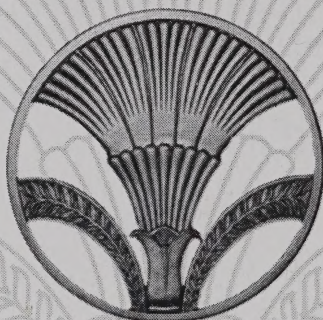


ALBERT R. MANN LIBRARY
CORNELL UNIVERSITY



CORNELL UNIVERSITY LIBRARY



3 1924 097 818 078

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

Volume 92

April–June 2005

CONTENTS

- Systematics of the *Saprolegniaceae*: new taxa
T.W. Johnson, Jr., R.L. Seymour & D.E. Padgett 1
- Systematics of the *Saprolegniaceae*: new combinations
T.W. Johnson, Jr., R.L. Seymour & D.E. Padgett 11
- Kochmania*, a new genus of smut fungi and new records of cypericolous species
from Poland and Ukraine Marcin Piątek 33
- Parapyricularia brasiliensis*, a new dematiaceous hyphomycete on *Gmelina*
arborea from Brazil Adriano Márcio Freire Silva,
Maria Angélica Guimarães Barbosa, Maria Menezes & Marcos P. S. Câmara 43
- Ramularia pistiae* sp. nov. — a new leaf spot fungus on water lettuce (*Pistia*
stratiotes) from Nicaragua R.C. Fernandes & R.W. Barreto 49
- Taxonomic revision of the genus *Cladosporium* s. lat. 3. A revision of
Cladosporium species described by J.J. Davis and H.C. Greene (WIS)
Konstanze Schubert 55
- Revision of three species of *Tricholoma* reported from China H. Deng & Y.-J. Yao 77
- Basidiomycetous pathogens on grapevine: a new species from Australia —
Fomitiporia australiensis Michael Fischer, Jacqueline Edwards,
James H. Cunningham & Ian G. Pascoe 85
- Morphology and species identification of a *Hypocrella* species (genbank accession
U47832) Amanjeet K. Bath, Monica S. Torres, Gary J. Samuels
& James F. White, Jr. 97
- Contribution to the lignocellulolytic fungi (Basidiomycetes) of the Atlantic Rain
Forest in Southern Brazil Claudia Groposo & Clarice Loguercio-Leite 103
- Moist chamber culture and field collections of Ecuador myxomycetes
Roland McHugh 107
- A new species of *Lentinus* from India T.K. Arun Kumar & P. Manimohan 119
- Morphology and taxonomy of the European species in *Lactarius* sect. *Deliciosi*
(*Russulales*) Jorinde Nuytinck & Annemieke Verbeken 125
- Aseröë floriformis*, a new phalloid with a sunflower-shaped receptacle
I.G. Baseia & F.D. Calonge 169
- Exserohilum heteromorphum* sp. nov., a new helminthosporioid fungus from
Echinochloa in China Guangyu Sun, Rong Zhang, Wang Zhou & Mingqi Zhu 173
- New records of Ascomycetes from Jalisco State, Mexico
María del Refugio Sánchez-Jácome & L. Guzmán-Dávalos 177

[Content continues inside front cover]

ISSN 0093-4666

MYXNAE 92: 1–506 (2005)

For subscription details, availability on microform, and
availability of articles as photocopies or tear sheets, see back cover

<i>Monacrosporium multiseptatum</i> , a new predacious fungus from China	
Hongyan Su, Yan Li, MingHe Mo & Keqin Zhang	193
<i>Verticimonosporium verticale</i> sp. nov. from Jiangxi Province, China	
Mu Wang, Li-Mei Zhang & Xing-Zhong Liu	197
New and rare lichenicolous fungi and lichens from the North American Arctic	
M.P. Zhurbenko, G.A. Laursen & D.A. Walker	201
A new species of <i>Paecilomyces</i> isolated from the Antarctic springtail	
<i>Cryptopygus antarcticus</i> P.D. Bridge, M.S. Clark & D.A. Pearce	213
Notes on Discomycetes (<i>Helotiales</i> , <i>Pezizales</i>): New species and new records from Cameroon	
Clovis Douanla-Meli & Ewald Langer	223
Myxomycetes of Mezit Stream Valley of Turkey	
C. Cem Ergül, Başaran Dülger & Hasan Akgül	239
A new species of <i>Dacryopinax</i> from Mexico	
Sigfrido Sierra & Joaquín Cifuentes	243
New rust fungi (<i>Uredinales</i>) from Mt. Elgon, Uganda	
Halvor B. Gjerum, Mary Namaganda & Kåre Arnstein Lye	251
<i>Gyalecta canariensis</i> sp. nov., a new lichen (Ascomycota) described from La Palma (Canary Islands)	
P.P.G. van den Boom & A. Vězda	255
A new <i>Ophiostoma</i> species isolated from <i>Pinus pinaster</i> in the Iberian Peninsula	
M. Villarreal, V. Rubio, M.T. de Troya & F. Arenal	259
Two new species of <i>Urocystis</i> (<i>Urocystales</i>) from China	
Lin Guo	269
<i>Pseudocercospora siparunae</i> - a new cercosporoid fungus from the Brazilian tropical forest	
Dartanha J. Soares & Robert W. Barreto	273
Two new hyphomycetous fungal species from India	
G. Sureshkumar, K. Sharath Babu, I.K. Kunwar & C. Manoharachary	279
<i>Erysiphe pachypodii</i> - a new species on <i>Pachypodium lamerei</i>	
Aleš Lebeda, Barbora Mieslerová & Ivana Doležalová	285
<i>Dactylella zhongdianensis</i> sp. nov, a new predacious antagonist of nematodes	
Jing Zhang, MingHe Mo, JingShi Deng, XueFeng Liu, TingJu Bi & KeQin Zhang	289
Isozyme analysis of twelve species of the genus <i>Ascobolus</i>	
Diana A. Dokmetzian, María E. Ranalli & Beatriz O. Saidman	295
Two new species of the genus <i>Paecilomyces</i> in China	
Yanfeng Han, Huali Chu & Zongqi Liang	311
<i>Aleurocystis gloeocystidiata</i> sp. nov. on <i>Polylepis australis</i> in Argentina	
Mario Rajchenberg & Gerardo L. Robledo	317
Noteworthy microfungi from air samples	
Analie A. Fernando, Susan E. Anagnost, Shannon R. Morey, Shuang Zhou, Catharine M. Catranis & C.J.K. Wang	323
What is <i>Oospora oryzetorum</i> ?	
Walter Gams & Amy Y. Rossman	339
New lichen records from Turkey	
Kenan Yazici, Ali Aslan & André Aptroot	341
A new polypore on Ginkgo from China	
Yu-Cheng Dai & Zheng Wang	345

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

A. R. MANN LIBRARY

JUL 21 2005

ITHACA, NY 14853

Volume 92, 2005

COMPLETE IN ONE VOLUME

CONSISTING OF VI +506 PAGES, INCLUDING FIGURES

EDITOR-IN-CHIEF

Lorelei L. Norvell
Pacific Northwest Mycology Service
6720 NW Skyline Boulevard
Portland, Oregon 97229-1309 USA

ASSOCIATE EDITORS

BOOK REVIEW EDITOR

David L. Hawksworth
MycoNova, Calle Aguila 12
Colonia La Maliciosa, Mataelpino
ES-28411 Madrid, Spain

FRENCH LANGUAGE EDITOR

Grégoire Hennenbert
32 Rue de l'Élevage
B-1340 Ottignies – LLN, Belgium

INDEX EDITOR

Karen D. Gettelman
8 Short Street
Cambridge, CB1 1LB, U. K.

EDITORIAL ADVISORY BOARD

GARY J. SAMUELS, Beltsville, Maryland, USA (1997-2006), Chair
SEPPU HUHTINEN, Turku, Finland (2000-2005), Past Chair
DONALD H. PFISTER, Cambridge, Massachusetts, USA (1997-2007)
WEN-YING ZHUANG, Beijing, China (2003-2008)
CAROL A. SHEARER, Urbana, Illinois, USA (1998-2009)
???RANDOLPH S. CURRAH, Edmonton, Alberta, Canada (1999-2010)

Published by
MYCOTAXON, LTD., P. O. BOX 264
ITHACA, NY 14851-0264, USA

www.mycotaxon.com

Printed in the United States of America

© Mycotaxon, Ltd., 2005

MYCOTAXON

VOLUME NINETY-TWO TABLE OF CONTENTS

Systematics of the <i>Saprolegniaceae</i> : new taxa	T.W. Johnson, Jr., R.L. Seymour & D.E. Padgett	1
Systematics of the <i>Saprolegniaceae</i> : new combinations	T.W. Johnson, Jr., R.L. Seymour & D.E. Padgett	11
<i>Kochmania</i> , a new genus of smut fungi and new records of cypericolous species from Poland and Ukraine	Marcin Piątek	33
<i>Parapyricularia brasiliensis</i> , a new dematiaceous hyphomycete on <i>Gmelina arborea</i> from Brazil	Adriano Márcio Freire Silva, Maria Angélica Guimarães Barbosa, Maria Menezes & Marcos P. S. Câmara	43
<i>Ramularia pistiae</i> sp. nov. — a new leaf spot fungus on water lettuce (<i>Pistia stratiotes</i>) from Nicaragua	R.C. Fernandes & R.W. Barreto	49
Taxonomic revision of the genus <i>Cladosporium</i> s. lat. 3. A revision of <i>Cladosporium</i> species described by J.J. Davis and H.C. Greene (WIS)	Konstanze Schubert	55
Revision of three species of <i>Tricholoma</i> reported from China	H. Deng & Y.-J. Yao	77
Basidiomycetous pathogens on grapevine: a new species from Australia — <i>Fomitiporia australiensis</i>	Michael Fischer, Jacqueline Edwards, James H. Cunnington & Ian G. Pascoe	85
Morphology and species identification of a <i>Hypocrella</i> species (genbank accession # U47832)	Amanjeet K. Bath, Monica S. Torres, Gary J. Samuels & James F. White, Jr.	97
Contribution to the lignocellulolytic fungi (Basidiomycetes) of the Atlantic Rain Forest in Southern Brazil	Claudia Groposo & Clarice Loguercio-Leite	103
Moist chamber culture and field collections of Ecuador myxomycetes	Roland McHugh	107
A new species of <i>Lentinus</i> from India	T.K. Arun Kumar & P. Manimohan	119
Morphology and taxonomy of the European species in <i>Lactarius</i> sect. <i>Deliciosi</i> (Russulales)	Jorinde Nuytinck & Annemieke Verbeken	125
<i>Aseroë floriformis</i> , a new phalloid with a sunflower-shaped receptacle	I.G. Baseia & F.D. Calonge	169
<i>Exserohilum heteromorphum</i> sp. nov., a new helminthosporioid fungus from <i>Echinochloa</i> in China	Guangyu Sun, Rong Zhang, Wang Zhou & Mingqi Zhu	173
New records of Ascomycetes from Jalisco State, Mexico	María del Refugio Sánchez-Jácome & L. Guzmán-Dávalos	177
<i>Monacrosporium multiseptatum</i> , a new predacious fungus from China	Hongyan Su, Yan Li, MingHe Mo & Keqin Zhang	193

- Verticimonosporium verticale* sp. nov. from Jiangxi Province, China
Mu Wang, Li-Mei Zhang & Xing-Zhong Liu 197
- New and rare lichenicolous fungi and lichens from the North American Arctic
M.P. Zhurbenko, G.A. Laursen & D.A. Walker 201
- A new species of *Paecilomyces* isolated from the Antarctic springtail
Cryptopygus antarcticus **P.D. Bridge, M.S. Clark & D.A. Pearce** 213
- Notes on Discomycetes (*Helotiales*, *Pezizales*): New species and new records
 from Cameroon **Clovis Douanla-Meli & Ewald Langer** 223
- Myxomycetes of Mezit Stream Valley of Turkey
C. Cem Ergül, Başaran Dülger & Hasan Akgül 239
- A new species of *Dacryopinax* from Mexico
Sigfrido Sierra & Joaquín Cifuentes 243
- New rust fungi (*Uredinales*) from Mt. Elgon, Uganda
Halvor B. Gjørum, Mary Namaganda & Kåre Arnstein Lye 251
- Gyalecta canariensis* sp. nov., a new lichen (Ascomycota) described from
 La Palma (Canary Islands) **P.P.G. van den Boom & A. Vězda** 255
- A new *Ophiostoma* species isolated from *Pinus pinaster* in the Iberian
 Peninsula **M. Villarreal, V. Rubio, M.T. de Troya & F. Arenal** 259
- Two new species of *Urocystis* (*Urocystales*) from China
Lin Guo 269
- Pseudocercospora siparunae* - a new cercosporoid fungus from the Brazilian
 tropical forest **Dartanha J. Soares & Robert W. Barreto** 273
- Two new hyphomycetous fungal species from India
**G. Sureshkumar, K. Sharath Babu,
 I.K. Kunwar & C. Manoharachary** 279
- Erysiphe pachypodii* - a new species on *Pachypodium lamerei*
Aleš Lebeda, Barbora Mieslerová & Ivana Doležalová 285
- Dactylella zhongdianensis* sp. nov., a new predacious antagonist of nematodes
**Jing Zhang, MingHe Mo, JingShi Deng,
 XueFeng Liu, TingJu Bi & KeQin Zhang** 289
- Isozyme analysis of twelve species of the genus *Ascobolus*
Diana A. Dokmetzian, María E. Ranalli & Beatriz O. Saidman 295
- Two new species of the genus *Paecilomyces* in China
Yanfeng Han, Huali Chu & Zongqi Liang 311
- Aleurocystis gloeocystidiata* sp. nov. on *Polylepis australis* in Argentina
Mario Rajchenberg & Gerardo L. Robledo 317
- Noteworthy microfungi from air samples **Analie A. Fernando,**
Susan E. Anagnost, Shannon R. Morey, Shuang Zhou,
Catharine M. Catranis & C.J.K. Wang 323
- What is *Oospora oryzetorum*?
Walter Gams & Amy Y. Rossman 339
- New lichen records from Turkey
Kenan Yazici, Ali Aslan & André Aptroot 341

A new polypore on Ginkgo from China	Yu-Cheng Dai & Zheng Wang	345
<i>Phaeoacremonium</i> species and <i>Phaeomoniella chlamydospora</i> distinguished through cultural characters and rDNA sequence analysis	Elizabeth Whiting, Marcos Cunha & W. Douglas Gubler	351
Taxonomy and nomenclature of <i>Gymnopilus bellulus</i> and <i>G. microsporus</i> (Agaricales, Cortinariaceae)	Jan Holec	361
A new species of <i>Pucciniastrum</i> on <i>Enkianthus campanulatus</i> from Japan	Ying-Mei Liang, Cheng-Ming Tian, Kazuyuki Hiratsuka & Makoto Kakishima	371
<i>Oidium moluccanum</i> nov. sp. causing powdery mildew on <i>Aleurites moluccanus</i> in East Timor	J.R. Liberato, P.M. Stephens & R. G. Shivas	377
A new species of <i>Acrogenospora</i> from submerged Bamboo in Yunnan, China	Hong Zhu, Lei Cai, Kevin D. Hyde & Keqin Zhang	383
Some trans-septate species of the genera <i>Hemithecium</i> and <i>Platythecium</i> from India	Bharati Adawadkar & Urmila Makhija	387
Additions and corrections to names published in <i>Cercospora</i> and <i>Passalora</i>	Uwe Braun & Pedro W. Crous	395
Taxonomic studies of <i>Corynespora</i> from China	Xiu-Guo Zhang & Cheng-Kuei Shi	417
Taxonomic studies of <i>Corynespora</i> from Yunnan	Xiu-Guo Zhang & Min Ji	425
Taxonomic studies of <i>Corynespora</i> from Guangxi, China	Xiu-Guo Zhang & Jun-Jie Xu	431
Preliminary checklist of the basidiomycetes from mediterranean inland dune ecosystems of Seville (Spain)	A. Ortega & F. Esteve-Raventós	437
<i>Xanthoparmelia viriduloumbrina</i> , a neglected species from eastern North America	James C. Lendemer	441
A revision of <i>Albugo</i> (Chromista, Peronosporomycetes)	Marco Thines & Otmar Spring	443
<i>Apiognomonina fakirovae</i> sp. nov. (Diaporthales) on <i>Quercus cerris</i> (Fagaceae)	Dimitar Y. Stoykov	459
<i>Physarum styriacum</i> , a synonym of <i>Physarum vernum</i>	G. Moreno, H. Singer & C. Illana	463
Book reviews and notices	David L. Hawksworth	469
Nomenclatural novelties proposed in MYCOTAXON 92		497
Author index for MYCOTAXON 92		500
MYCOTAXON online resources (INDEX TO FUNGOUS AND LICHEN TAXA, cumulative indices, distributional checklists, search features)		504
Reviewers for MYCOTAXON 92		505
Errata for Volume 91		506

PUBLICATION DATE FOR VOLUME NINETY-ONE

MYCOTAXON *for* JANUARY–MARCH, VOLUME 91 (1–536 + i–vi)
was issued on March 30, 2005

Systematics of the *Saprolegniaceae*: New taxa

T. W. JOHNSON, JR.,¹ R. L. SEYMOUR² & D. E. PADGETT³

¹3505 Manford Dr., Durham, NC 27707, USA

²403 N. West St., Palestine, IL 62451, USA

³padgett@uncw.edu

Dept. of Biological Sciences, Univ. of NC at Wilmington
601 S. College Rd., Wilmington, NC 28403, USA

Abstract – The new genus *Phragmosporangium* and its sole species *P. uniseriatum*, *Leptolegnia hemihypogyna*, *Pythiopsis irregularis*, *P. papilliformis*, and *Saprolegnia truncata* are described. Chief characteristics defining these new taxa and distinguishing them from others are recorded.

Key word – watermold

In the course of making worldwide collections of watermolds for a monographic revision of the *Saprolegniaceae* (Johnson, Seymour & Padgett 2002), we isolated five new species, one of which represents a new genus. These taxa are described herein and contrasted with previously recognized members of the family.

All specimens were isolated from soil samples by transferring one tablespoon of soil to disposable Petri dishes containing 20 mL of sterile, charcoal-filtered distilled water. Boiled, split hempseed halves then were added as bait, and the culture dishes incubated at room temperature until hyphal growth was visible to the unaided eye. Axenic, single spore cultures were derived using standard procedures (Johnson, Seymour & Padgett 2002) and propagated for morphological characterization on sterilized hempseeds in water culture.

The numbered illustrations accompanying this account have extracted counterparts in the designated and deposited holotypes. Figures 1–11 correspond precisely to Figures 103 L–S, W–Y (holotype), for example.

Taxonomic Account

Leptolegnia hemihypogyna Seymour, *sp. nov.*

FIGURES 1–11

Monoecia. Mycelium modice amplum et densum; hyphae graciles, ramis paucis. Sporangia filamentosa, 20–280 x 8–24 μm . Sporae dimorphae, quarum primariae usque ad 18 μm longae in series simplices ordinatae, secundariae reniformes; cystae 9–14 μm diam. Sine gemmis. Oogonia terminalia vel lateralia, raro intercalaria; abunda, plerumque sphaerica vel paulo abnormia (24–) 26–29 (–34) μm diam.

Ornamentis comprehensis; tunica puteolata sub juncturis cellarum antheridialium; plerumque levis vel scabra vel raro papillata. Oosporae subeccentricae; sphaericae vel ovatae (22-) 24-26 (-31) μm diam.; singulae. Antheridia hemihypogyna, raro androgyna, monoclina vel hypogyna; perstantia; cellulae simplices ad apicem vel ad latus appressae.

Monoecious. Mycelium dense, moderately extensive; hyphae slender, sparsely branched, (8-) 10-14 (-24) μm diam. Sporangia filamentous, rarely branched; 20-280 x 8-24 μm . Spores dimorphic; in a single row in the sporangium; motile at discharge; primary ones cylindrical, up to 18 μm long; secondary ones reniform, cysts 9-14 μm diam. Gemmae lacking. Oogonia lateral or terminal, rarely intercalary; spherical or slightly irregular; (24-) 26-29 (-34) μm diam., including wall ornamentations. Oogonial wall pitted under area of antheridial cell attachment; smooth, irregular, or sparsely provided with short, broad projections or papillae. Oogonial stalks generally less than the diameter of the oogonium, in length; stout or slender, straight or slightly curved; rarely branched. Oospores subeccentric; spherical, rarely ovoid; single in an oogonium, and usually not filling it; (22-) 24-26 (-31) μm diam.; germination not observed. Antheridial branches usually hemihypogynous, in old or contaminated cultures, androgynous, monoclinal or hypogynous; persisting. Antheridial cells simple; also apically or laterally appressed; persisting; fertilization tubes present, usually not persisting.

Holotype: Fig. 103L-S, W-Y; Accession Nr. MS 243, William Madison Randall Library Special Collection, University of North Carolina at Wilmington, Wilmington, NC 28403 (USA).

Type locality: island soil, Rio Negro, Manaus, Brazil, 25 February 1978.

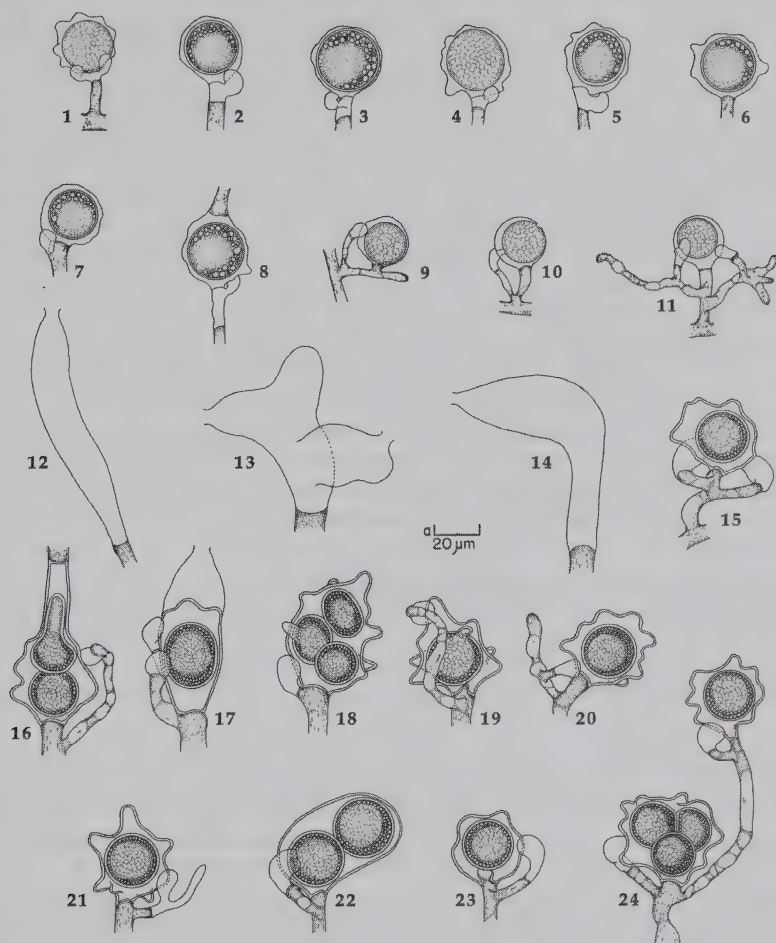
SPECIMENS EXAMINED: --SOUTH AMERICA (3).

DISCUSSION--The configuration of the sexual apparatus of *Leptolegnia hemihypogyna* is somewhat unstable in culture. In old cultures (staling water) or in water containing soil or organic debris, the fungus produces oogonia that are for the most part smooth and spherical (Fig. 10) or slightly irregular (Fig. 7). The antheridial apparatus is generally well developed; androgynous (Fig. 11) or monoclinal (Fig. 9) branches predominate. In axenic culture, in fresh water prior to the accumulation of staling products, the fungus often produces irregular or ornamented oogonia (Figs. 1, 2) attended generally by hemihypogynous antheridial cells (Figs. 2-5). *Leptolegnia hemihypogyna* shares with *L. caudata* and *L. subterranea* the characteristic of subeccentric oospores. There is no antheridial apparatus in *L. subterranea*, and *L. caudata* has only declinal antheridial branches. One of the chief features of recognition for the new taxon is its hemihypogynous antheridial cells.

Pythiopsis irregularis Seymour, *sp. nov.*

FIGURES 12-24

Monoecia. Mycelium amplum; hyphae graciles (8-) 10-14 (-24) μm diam., ramis paucis. Sporangia navicularia, 91-163 x 24-38 μm , vel lobata 90-115 x 77-86 μm , vel irregularia. Sporae monomorphae; cystae 8-15 μm diam. Gemmae in culturis vetustioribus abundantes, plerumque levis, variformes. Oogonia abunda, terminalia vel lateraliter intercalaria; sphaerica vel irregularia, (29-) 33-37 (-52) μm diam., interdum oblonga vel clavata; tunica puteolata sub juncturis cellarum antheridialium, raro alibi; irregularis vel papillata, raro levis. Oosporae 1-2 (-3)



FIGS. 1-24. *Leptolegnia hemihypogyna* and *Pythiopsis irregularis*. 1-11: *Leptolegnia hemihypogyna*. 1-7. Variations in oogonial shape, and degree of wall ornamentation; where present, hemihypogynous antheridial cells; subeccentric oospores. 8. Intercalary oogonium. 9-11. Smooth-walled, immature oogonia; antheridial branches androgynous. 12-24: *Pythiopsis irregularis*. 12-14. Variations in sporangial shape. 15-24. Variations in location, shape, and abundance of oogonial wall ornamentations; androgynous antheridial branches; subcentric oospores. All figures scale a.

per oogonium, subcentricae aut raro centricae, sphaericae vel ovaes, (22-) 27-29 (-38) μm diam. Antheridia androgyna; cellulae simplices, ad apicem vel ad latus appressae.

Monoecious. Mycelium extensive; hyphae slender, sparingly branched. Sporangia naviculate, lobed, or irregularly swollen; discharge papillae conspicuous, with slightly thickened, flaring wall; renewed internally or cymosely; not persisting; lobed sporangia 90-115 x 77-86 μm , naviculate ones 91-163 x 24-38 μm . Spores monomorphic; discharge and behavior of primary spores saprolegnoid, but no secondary ones produced; primary spore cysts 8-15 μm diam. Gemmae abundant in old cultures; variable in shape; generally smooth-walled; terminal, lateral, or intercalary; single or catenulate. Oogonia terminal, lateral, or intercalary; rarely developing in discharged sporangia; generally irregular and prominently ornamented, occasionally dolioform, cylindrical, or clavate, rarely angular or spherical; (29-) 33-37 (-52) μm diam., inclusive of wall projections. Oogonial wall sometimes pitted under region of attachment of antheridial cells, very rarely elsewhere as well; provided with short, broad, conspicuous papillae or bullations uniformly thickened throughout; very rarely smooth. Oogonial stalks 1-3 times the diameter of the oogonium in length; stout, straight or curved, seldom branched. Oospores subcentric, very rarely centric; spherical or oval; 1-2 (-3) per oogonium, but not filling it; (22-) 27-29 (-38) μm diam.; germination unknown. Antheridial branches androgynous; short, occasionally sparingly branched; generally 1-2 per oogonium; persisting. Antheridial cells simple; clavate or tubular, occasionally sharply bent, infrequently lobed or once-branched; persisting; apically or laterally appressed; fertilization tubes present but not persisting.

Holotype: Fig. 86A-M; Accession Nr. MS 245, William Madison Randall

Library Special Collection, University of North Carolina at Wilmington, Wilmington, NC 28403 (USA).

Type locality: bog soil, El Yunque, Puerto Rico, 12 January 1974.

SPECIMENS EXAMINED -- AUSTRALIA (1), SOUTH AMERICA (4), UNITED STATES (1), WEST INDIES (2).

DISCUSSION -- The sporangia of *Pythiopsis irregularis* are exceptionally variable in shape, but each characteristically has a terminal, conspicuous discharge papilla. After spore release the cylindrical remnant of the exit apparatus is prominently flared (Figs. 12, 13), but other members of the genus may exhibit a similar feature.

Generally stout, prominent papillae (Figs. 18, 21) project from the oogonia of *Pythiopsis irregularis*, but in those instances when the ornamentations show a low profile, the oogonium has an irregular configuration (Fig. 23). The wall irregularities are uniformly thickened throughout, in contrast to the condition in *P. papilliformis*. In common with *P. cymosa* and *P. humphreyana*, *P. irregularis* often has short, unbranched, androgynous antheridial branches (Fig. 18), but the new species lacks a hemihypogynous antheridial apparatus such as that found in the former two taxa. While the oogonia of *P. humphreyana* ordinarily are irregular in general configuration, they are not as prominently papillate as are those of *P. irregularis* (Fig. 24). Where conspicuous wall extensions are produced by oogonia of *P. humphreyana*, they are sparse rather than abundant as in *P. irregularis*.

Pythiopsis irregularis is widespread in tropical regions, where it is commonly found in conjunction with *P. humphreyana*. In these areas, *P. irregularis*, like other members of the genus, is seemingly restricted to cool, wet habitats such as montane bogs, marshes, and rainforest soils.

Pythiopsis papilliformis Seymour, *sp. nov.*

FIGURES 25-29

Monoecia. Mycelium amplum; hyphae gracile, ramis paucis. Sporangia cylindrica, clavata, lobata, elliptica, obovata, sphaerica vel irregularia; 40-230 x 21-84 μm , papillis 1-3 emissis. Sporae monomorphae; cystae 8-13 μm diam. Gemmae infrequentes; plerumque glabro-tunicatae, clavatae vel sphaericae vel obpyriformes; terminales vel laterales vel intercalares. Oogonia abunda, terminalia vel lateralia vel intercalaria; sphaerica (42-) 46-59 (-67) μm diam., vel paulo abnormia vel interdum clavata, 53-103 x 25-60 μm (sine ornamentis) vel obpyriformia; tunica puteolata sub juncturis cellarum antheridialium, raro alibi; dense aut sparsim papillata, 7-48 x 7-22 μm ; ornamentis ad apicem rotundis et tenuiter tunicatis. Oosporae 1-2 (-5), subcentricae aut raro centricae, quarum sphaericae (21-) 38-42 (-45) μm diam. vel ellipsoideae 38-48 x 33-46 μm . Antheridia 1-2 per oogonium, androgyna vel raro monoclina, non perstantia; cellulae simplices, ad apicem vel raro ad latus appressae.

Monoecious. Mycelium extensive; hyphae slender, sparingly branched. Sporangia cylindrical, clavate, lobed, ellipsoidal, obovate, globose, or irregular; discharge papillae occasionally subapical; renewed cymosely, rarely internally; not persisting; 40-230 x 21-84 μm . Spores monomorphic; discharge and behavior of primary spores saprolegnoid, but no secondary spores produced; primary spore cysts 8-13 μm diam. Gemmae rare; clavate, spherical, or obpyriform; usually smooth-walled; terminal, lateral, or intercalary; single, rarely catenulate. Oogonia terminal, lateral, or intercalary; single, occasionally catenulate; spherical to slightly irregular or occasionally elongate, dolioform, subglobose, or obpyriform, but always conspicuously ornamented; spherical ones (42-) 46-59 (-67) μm diam., exclusive of wall ornamentations; elongate ones 53-103 x 25-60 μm , exclusive of wall projections. Oogonial wall pitted under region of attachment of antheridial cells, rarely elsewhere; provided abundantly or sparsely with conspicuous, broadly to narrowly cylindro-conical projections rounded or nearly truncate and thin-walled at the apex; ornamentations 7-48 x 7-22 μm . Oogonial stalks 1-6 times the diameter of the oogonium, in length; stout or slender; primary oogonium straight, curved, sharply bent, or irregular; seldom branched. Oospores subcentric, rarely centric; spherical or ellipsoidal; 1-2 (-5) per oogonium and filling it or not; spherical ones (21-) 38-42 (-45) μm diam., ellipsoidal ones 38-48 x 33-46 μm ; germination unknown. Antheridial branches androgynous, rarely monoclinal; slender, seldom irregular or branched; usually 1-2 per oogonium; not persisting. Antheridial cells simple; broadly clavate or short tubular, straight or sharply bent; persisting; apically appressed, rarely laterally attached; fertilization tubes present but not persisting.

Holotype: Figs. 87A-C, 86 N-O; Accession Nr. MS 246, William Madison Randall Library Special Collection, University of North Carolina at Wilmington, Wilmington, NC 28403 (USA).

Type locality: roadside forest soil, highway BR 174 to Boa Vista 74.1 km from Manaus, Brazil, 5 March 1978.

SPECIMENS EXAMINED: SOUTH AMERICA (14).

DISCUSSION -- In this species, the oogonial wall ornamentations constitute the chief feature of recognition. They are cylindro-conical, for the most part generally rather long (7-48 μm), and are thin-walled at the rounded or nearly truncate apex (Fig. 27). The nature of the apex of the wall projections distinguishes *Pythiopsis papilliformis* immediately from *P. irregularis*; in the latter, the wall of the ornamentations is uniformly thickened. In our experience, the sporangia of *P. papilliformis* are much less abundant than are those of *P. irregularis*.

Like *Pythiopsis papilliformis*, *Achlya recurva* has prominent oogonial wall ornamentations that are thin at the apex. The two species cannot be confused, however, because of the considerable difference in spore behavior, and the fact that the *Achlya* has eccentric rather than centric or subcentric oospores.

Geographically, *Pythiopsis papilliformis* is known only from Amazonas. It occurs commonly in this area in moist, rainforest soil along with *P. irregularis* and *P. humphreyana*.

***Phragmosporangium* Seymour, gen. nov.**

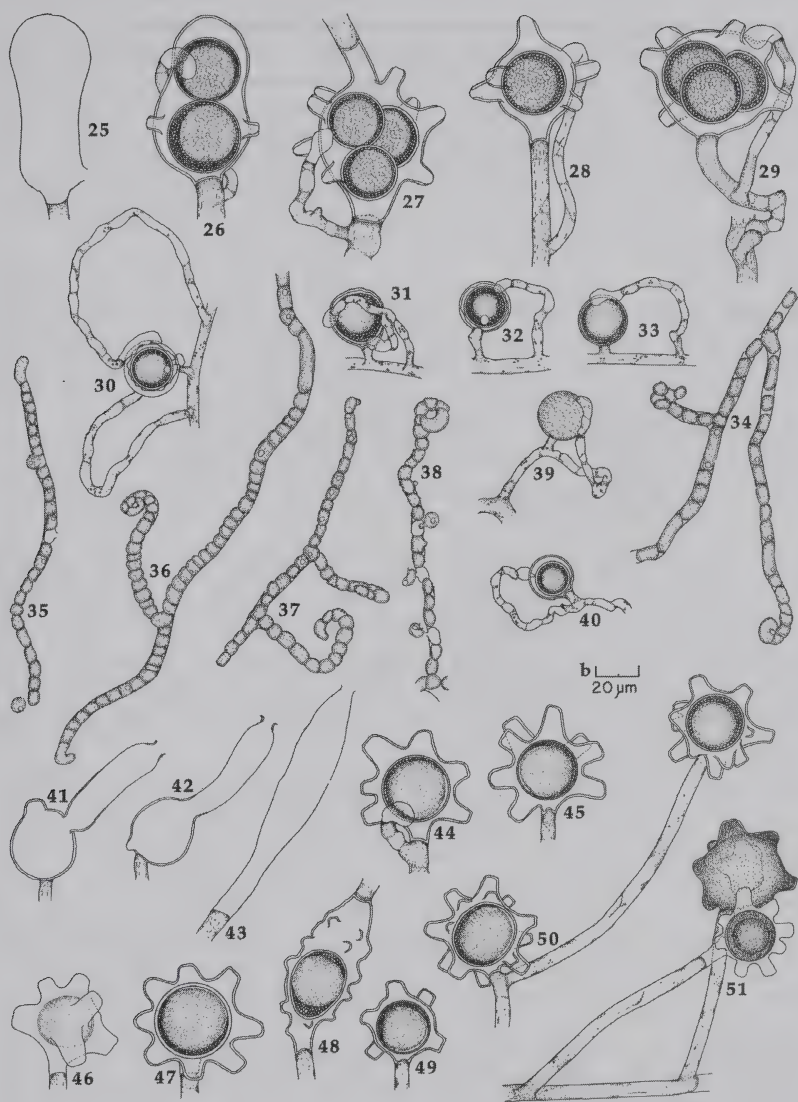
Monoecium. Sporangia filamentosa, ramosa vel ramis carentia. Sporae monomorphae, dictyoiditer liberatae; sporae primariae in seriem singularem ordinatae. Sine gemmis. Oogonia copiosa, terminalia vel lateral; plerumque sphaerica vel paulo abnormia; tunica sine punctis, in facie interiore irregularis. Oosporae singulae et subcentricae. Antheridia monoclina vel androgyna.

Monoecious. Mycelium delicate, extensive. Sporangia filamentous; unbranched or branched. Spores monomorphic; discharge and behavior dictyucoid. Gemmae unknown. Oogonia terminal or lateral; spherical or slightly irregular. Oogonial wall thin or thickened, sometimes irregular on inner surface; unpitted. Oogonial stalks short, unbranched. Oospores subcentric; single. Antheridial branches monoclinal or androgynous. Antheridial cells simple; apically or laterally appressed.

Type species: *Phragmosporangium uniseriatum*.

This is a distinctive genus, its single known species recognized by the long, filamentous sporangia that release spores in a dictyucoid fashion. The sporangia are unbranched or branched, are sometimes sinuous or loosely coiled, and the apical cell is often strongly curved.

FIGS. 25-51. *Pythiopsis papilliformis*, *Phragmosporangium uniseriatum*, and *Saprolegnia truncata*. 25-29: *Pythiopsis papilliformis*. 25. Discharged, subcylindrical sporangium. 26. Terminal oogonium; sparsely papillate. 27. Intercalary oogonium. 28, 29. Optical sections of mature oogonia; papillae rounded or truncate apically, and distally thin-walled; oospores subcentric. 30-40: *Phragmosporangium uniseriatum*. 30. Spherical oogonium; inner wall surface irregular; monoclinal antheridial branches. 31-33. Characteristic configuration of oogonia and attendant monoclinal antheridial branches; oospores subcentric. 34, 36, 37. Distal portions of hyphae converted into sporangia; wall of spore-bearing part of hypha partially deliquesced; ultimate cell of hyphae bent or recurved. 35, 38. Emergence of secondary planonts from encysted, primary, uniseriate spores; hyphal (sporangial) wall partially intact. 39. Immature oogonium. 41-51: *Saprolegnia truncata*. 41-43. Discharged sporangia. 44. Oogonium with a very short, androgynous antheridial branch. 45, 47, 49. Oogonia; subcentric oospores; no antheridial system. 46. Surface



view of papillate oogonium. 48. Intercalary oogonium. 50. Oogonium on a sympodial branch from below a primary sporangium; long-stalked, lateral oogonium. 51. Immature oogonium on a sympodial branch below a sporangium; long-stalked, lateral oogonium. All figures scale b.

Monoecium. Mycelium amplum; hyphae tenerae 7-12 μm diam., quarum filamenta singula integre in sporangia interdum mutata. Sporangia filamentosa, plerumque ramosa vel sine ramis, usque ad 1 mm longa. Sporae monomorphae, dictyoiditer liberatae; sporae primariae in seriem singularem ordinatae; cystae 8-18 μm diam. Sine gemmis. Oogonia abunda; terminalia vel lateralialia, sphaerica vel paulo abnormia; (23-) 25-29 (-33) μm diam.; tunica sine punctis, in facie exteriore levis, in facie interiore irregularis. Oosporae singulae, subcentricae; sphaericae (19-) 24-28 (-32) μm diam. Antheridia plerumque monoclina, interdum androgyna, perstantia; cellulae simplices, ad apicem vel ad latus appressae.

Monoecious. Hyphae delicate, 7-12 μm diam.; branched or unbranched. Sporangia filamentous, branched or unbranched, straight, sinuous, or loosely coiled; renewal pattern unknown; variable in length, often being formed by conversion of entire hypha; wall deliquescent or only partly so. Spores monomorphic; discharge and behavior dictyucoid; primary ones cylindrical or ellipsoidal, encysting in a single row in the sporangium, and terminal spore cyst often lunate; cysts 8-18 μm diam.; secondary spores reniform, cylindrical, or elongate, emerging through a short, flared, discharge papilla, and showing amoeboid motion, the cysts 10-14 μm diam. Gemmae unknown. Oogonia terminal or lateral, single or occasionally catenulate; spherical or slightly irregular; (23-) 25-29 (-33) μm diam. Oogonial wall thin or noticeably thickened, unpitted; inner surface smooth, roughened, or irregular; outer surface smooth or irregular. Oogonial stalks short, rarely exceeding in length the diameter of the oogonium; straight or slightly curved; unbranched. Oospores subcentric; spherical, and showing a pellucid spot; single, filling the oogonium or not; (19-) 24-28 (-32) μm diam., germination unknown. Antheridial branches monoclinal, occasionally androgynous; slender, sometimes branched; persisting. Antheridial cells simple; persisting; apically or laterally appressed; fertilization tubes present but not persisting.

Holotype: Fig. 117; Accession Nr. MS 244, William Madison Randall Library Special Collection, University of North Carolina at Wilmington, Wilmington, NC 28403 (USA).

Type locality: forest soil near Bassa, Liberia, 30 June 1970.

SPECIMENS EXAMINED: -- AFRICA (2; holotype, Liberia; lectotype, Nigeria).

DISCUSSION -- *Phragmosporangium uniseriatum* differs from species of *Dictyuchus* in certain of its sporangial configurations. Isolates of the mating strains of *D. monosporus* may have long, slender, branched sporangia, but these are not the result of the conversion of an entire hypha into a reproductive unit as is often the case in *P. uniseriatum*. Even though specimens of *Dictyuchus* may have some uniseriate sporangia, they are never exclusively of this type in a given individual. Moreover, no representatives of *Dictyuchus* have coiled, twisted sporangia with an elongate, strongly curved apical cell (Figs. 34, 38).

In soil/water culture prior to isolation, *Phragmosporangium uniseriatum* produces limited mycelium consisting of rather delicate hyphae intermingled among those of other water molds. This habit of growth, coupled with the linear spore arrangement may lead to some initial confusion in distinguishing the species from *Brevilegnia linearis* or from various members of *Aphanomyces*, *Geolegnia*, and *Leptolegnia* when sporangia are not evident.

Geographically, *Phragmosporangium uniseriatum* currently is known only from two sites in tropical West Africa. Whether or not the fungus should be regarded as a rare species is debatable. Like species of *Geolegnia*, *P. uniseriatum* does not form an easily recognizable or vigorous colony on hempseed, and thus may be overlooked in a hasty examination of initial soil/water cultures. In the decade between the initial recovery of *P. uniseriatum* from Liberian soil and its subsequent isolation from Nigeria, we have not found the fungus in some 10,000 soil samples from various tropical localities throughout the world.

***Saprolegnia truncata* Seymour, sp. nov.**

FIGURES 41-51

Monoecia. Mycelium limitatum et compactum; hyphae modice robustae, parce ramosae. Sporangia rara; navicularia vel cylindrica, ca. 120 x 28 μm . Sporae dimorphae; cystae 9-13 μm diam. Gemmae naviculares vel sphaericae, singulae; tunica levis. Oogonia abunda, terminalia vel lateralia; plerumque sphaerica (18-) 34-38 (-45) μm diam. (sine ornamentis); tunica sine punctis, prominentibus truncis (9-) 14-16 (-29) μm longis ornata. Oosporae singulae per oogonium, raro duales; subcentricae; sphaericae vel ovatae, raro ellipticae (16-) 29-33 (-42) μm diam. Antheridia infrequentia, androgyna, non perstantia; cellulae simplices, ad latus appressae.

Monoecious. Mycelium limited, dense; hyphae moderately stout (16-) 24-26 (-35) μm diam., sparingly branched. Sporangia rare; naviculate or cylindrical, appearing very early or proliferating from immature oogonia after prolonged culture, then subspherical with a long, cylindrical exit tube; straight or slightly curved; renewal not observed; not persistent; averaging 120 x 28 μm ; discharge papilla with thickened, flaring wall; basal portion often thick-walled. Spores dimorphic; discharge and behavior saprolegnoid; cysts 9-13 μm diam. Gemmae, when present, naviculate or spherical; terminal or intercalary; single; smooth. Oogonia abundant; terminal or lateral, rarely intercalary; single; spherical, occasionally ovoid; (18-) 34-38 (-45) μm diam., exclusive of papillae. Oogonial wall unpitted; ornamented with prominent, truncate projections: (9-) 14-16 (-29) μm long, occasionally intermixed with papillae. Oogonial stalks up to 8 times the diameter of oogonium, in length; straight, slender, unbranched. Oospores subcentric; spherical or ovoid, occasionally ellipsoidal; 1, rarely 2 per oogonium, and plerotic or aplerotic; (16-) 29-33 (-42) μm diam., germination unknown. Antheridial branches rare; androgynous, usually arising immediately below the oogonium to which attached, single; not persistent. Antheridial cells simple; laterally appressed; persisting; fertilization tubes unknown.

Holotype: Fig. 91C-M; Accession Nr. MS 242, William Madison Randall Library Special Collection, University of North Carolina at Wilmington, Wilmington, NC 28403 (USA).

Type locality: roadside forest soil, highway BR 174 to Boa Vista, 60 km from Manaus, Brazil, 5 March 1978.

SPECIMEN EXAMINED: -- SOUTH AMERICA (1).

DISCUSSION -- Among the species of *Saprolegnia* with ornamented oogonia, *S. truncata* is distinctive by reason of its stout, prominent wall protrusions. These generally are truncate (Fig. 50) but on some oogonia (Fig. 47) a few rounded papillae also may be produced.

Essentially two types of sporangia are formed by *Saprolegnia truncata*. The terminal, thin-walled sporangia (Fig. 43) usually associated with species in the genus are rare, and we have not seen how they are renewed. The second type of sporangium—more commonly developed than the “typical” ones in our specimens—is in essence a reversal of an oogonial initial to a functional sporangium (Figs. 41, 42). These sporangia therefore are thick-walled and subspherical at the base, but thin-walled distally (except in the vicinity of the exit orifice). Release of spores from these sporangia is characteristically saprolegnoid. So far as we are aware, sporangia developed from converted oogonium initials are not found in any other species in the genus. The reversion of antheridial branches into vegetative hyphae or oogonia has been documented (Moreau & Moreau 1935; T. W. Johnson 1973).

Developmentally, *Saprolegnia truncata* is unique among members of the Saprolegniaceae. In most species propagated on hempseed in water culture, immature oogonia appear on colonies after 36 hours, but in *S. truncata*, the oogonia generally are formed and become mature within 8-12 hours following infestation of fresh hempseed. This extremely rapid appearance of oogonia may in some way be associated with suppression of the sporangial phase even during the early stages of mycelial development. This phenomenon commands further study from both a biochemical (regulatory) and developmental standpoint.

Saprolegnia truncata is the first discovery of a member of this genus in low-elevation, humid tropical areas. Some representatives of *Saprolegnia* have been recovered from tropical countries in soils at high elevations, but Fajola and his associates (1978) found *S. ferax* and *S. litoralis* in river soils in Nigeria.

Acknowledgements

We are pleased to acknowledge the following generous awards which made possible the field and laboratory work as well the preparation of this manuscript: National Science Foundation grant nrs. GB-8693, GB-13404, GB-26638, GB-27297, GB-35661, BMS-72-02352-A01, BMS-75-01155, DEB-76-20123-A01, DEB-0328316; U.S. Atomic Energy Commission contract nr. AT-(40-1)-3556; Office of Naval Research contract nr. 1181(15)NR104-820; Arctic Institute of North America under ONR contract N0014-72-A-0375-0002 (subcontract ONR-441). The late William H. Willis, Department of Classical Studies, Duke University, kindly prepared the Latin diagnoses. We are grateful to Dr. Martha Powell, Department of Biology, The University of Alabama, and Dr. Keith Seifert, Agriculture & Agri-Food Canada for their critical reviews of this manuscript.

Literature Cited

- Fajola AO, Alasoadura SO, Ogbonna CI. 1978. Some aquatic [*sic.*] Phycomycetes from riverine soils in Ibadan, Nigeria. *Nova Hedwigia* 29:905-911.
- Johnson Jr TW. 1973. Aquatic fungi of Iceland. *Achlya racemosa* Hildebrand. *Svensk Bot. Tidskr.* 67:438-444.
- Johnson Jr TW, Seymour RL, Padgett DE. 2002. Biology and systematics of the *Saprolegniaceae* (on-line publication accessible at http://aa.uncw.edu/digilib/biology/fungi/taxonomy%20and%20systematics/padgett/read_first/watermold_treatise_organization.htm)
- Moreau F, Moreau. 1935. Sur des phénomènes d'accrescence des organes de la reproduction sexuelle chez une Saprolegniacée. *Compt.-Rend. Hebd. Séances Mém. Soc. Biol.* 119:1256.

Systematics of the *Saprolegniaceae*: New combinations

T. W. JOHNSON, JR.,¹ R. L. SEYMOUR² & D. E. PADGETT³

¹3505 Manford Dr., Durham, NC 27707, USA

²403 N. West St., Palestine, IL 62451, USA

³padgett@uncw.edu

Dept. of Biological Sciences, Univ. of NC at Wilmington,
601 S. College Rd., Wilmington, NC 28403, USA

Abstract – *Achlya achlyoides*, *A. androgyna*, *A. irregularis*, *A. primoachlya*, *A. pseudoachlyoides*, *Protoachlya benekei*, *P. hypogyna*, *P. mucronata*, and *Saprolegnia itoana* are proposed as new combinations in the *Saprolegniaceae*. *Achlya ornata* is the new name for *Aplanopsis spinosa*, since *Achlya spinosa* is a preoccupied name.

Key words –watermold

Introduction

An account of the literature and research on the *Saprolegniaceae* from 1750 through the mid 1980's, treating their biology (including pathology) and systematics, was released in 2002 (Johnson, Seymour, and Padgett). The taxonomic treatment was based on available published literature and the study of hundreds of living specimens collected from a variety of New and Old World geographical and geophysical regions. Whatever information could be extracted from the few preserved specimens extant contributed also to the accumulated taxonomic data. With such a data base, it was possible to propose revisions in the systematics of the family. Where observations on the morphology of living representatives warranted it, generic boundaries were breached; this account records the resulting new combinations.

Separation of watermold genera has been based traditionally on the pattern of spore release (from sporangia), and their subsequent behavior. We established the premise that the primary sporangia, those first appearing in sterile water cultures of the isolates, were the definitive ones to examine. Spore discharge from later (secondary) sporangia also establish a range of discharge patterns. The following infrageneric new combinations (with the exception of the intrageneric *Saprolegnia itoana*) are based upon this primary sporangium concept.

Materials and Methods

Watermolds were collected by baiting with hempseed halves, soil or water (with or without debris) in Petri plates, and incubating the gross cultures at room temperature. Subsequent colonies established on the bait were then washed with distilled water, and

transferred to sterile plates containing sterile, charcoal-filtered, distilled water. From these colonies single spores (or hyphal tips in infrequent instances) were streaked on Cornmeal, or Emerson's YpSs agar media. Single, isolated germlings were then transferred on small blocks of agar to sterile, charcoal-filtered water, and baited with sterile hempseed halves. Observations and measurements were made on colonies developed on these baits. Incubation at room temperature proved to be adequate for vigorous growth of every representative we isolated.

Taxonomic Account

Achlya achlyoides (Coker and Alexander) Johnson and Seymour, *comb. nov.*

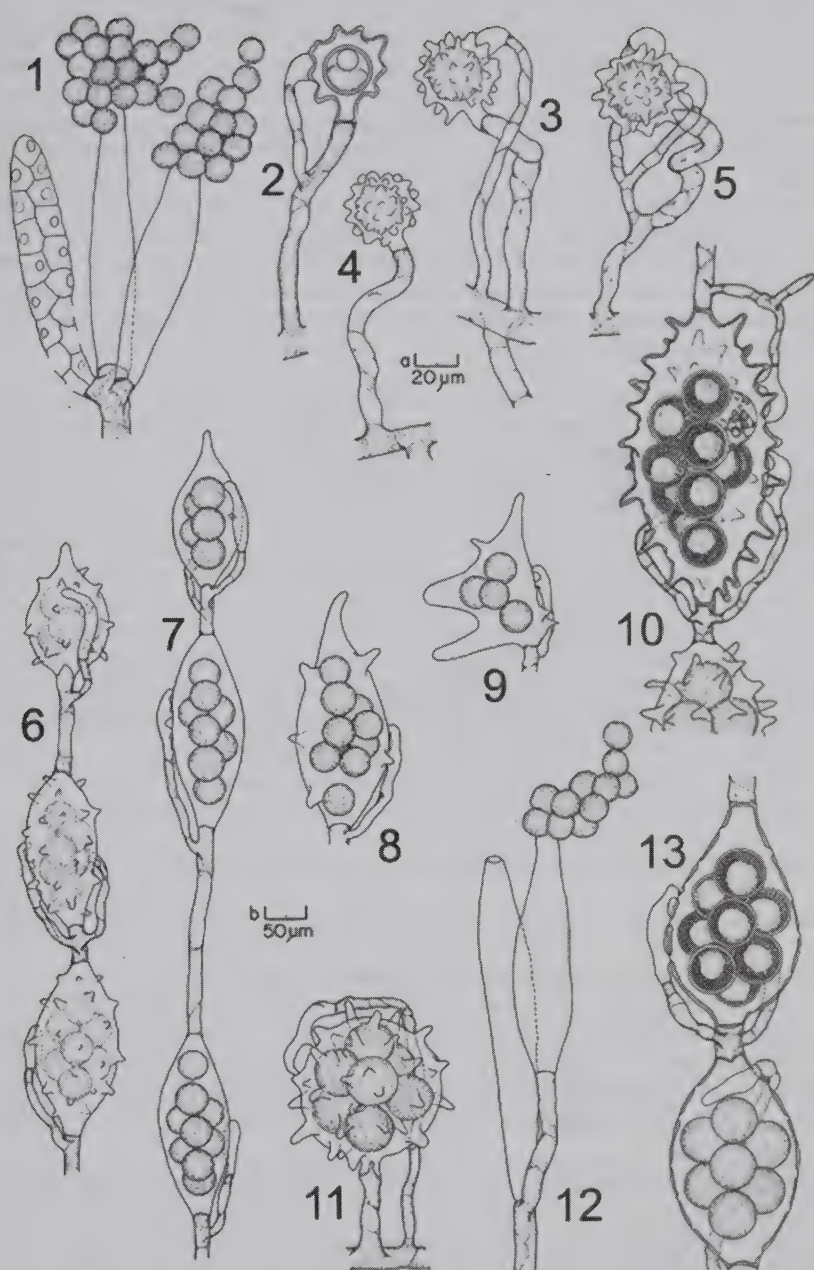
FIGURES 1-5

Basionym: *Dicytuchus achlyoides* Coker and Alexander, in Coker, J. Elisha Mitchell Sci. Soc. 42:218, pl.36. 1927.

Monoecious. Mycelium dense; hyphae slender, moderately branched. Sporangia cylindrical or fusiform, usually curved or slightly irregular; often branched or once-lobed; renewed sympodially or by cymose branching; 36-318 x 12-52 μm . Spores monomorphic; discharge and behavior of spores in primary sporangia achlyoid, in secondary ones achlyoid or dictyucoid; primary spore cysts 10-16 μm diam. Gemmae absent. Oogonia spherical, subspherical, or napiform; lateral, infrequently terminal; (18-) 26-32 (-48) μm diam., including wall ornamentations. Oogonial wall unpitted, densely or sparsely papillate, with some ornamentations cylindrical, truncate, or slightly indented. Oogonial stalks (1-) 2-4 (-11) times the diameter of the oogonium, in length; slender or stout; usually irregular, bent, or curved, infrequently sparingly coiled; unbranched or branched. Oospores eccentric; spherical; single, and occasionally nearly filling the oogonium; (16-) 22-28 (-33) μm diam.; germination not observed. Antheridial branches, when present, androgynous or monoclinal; slender, irregular or slightly curved; unbranched or branched; persisting. Antheridial cells simple; clavate, persisting; laterally or apically appressed; fertilization tubes not observed.

DISCUSSION -- *Achlya achlyoides* produces consistently a single oospore in each maturing papillate oogonium, and the secondary sporangia are always of two types, achlyoid and dictyucoid. The species can be identified primarily by these characteristics. *Achlya pseudoachlyoides* (also transferred from *Dictyuchus*) likewise has oogonia with only one oospore each but unlike the condition in *A. achlyoides* the oogonium wall is not ornamented.

FIGS. 1-13. *Achlya achlyoides* and *Achlya androgyna*. 1-5: *Achlya achlyoides*. 1. Terminal cluster of sporangia, two in achlyoid discharge, one with a dictyucoid pattern. 2. Papillate oogonium with androgynous antheridial branch; oospore eccentric. 3. Surface view of lateral oogonium with attendant monoclinal antheridial branch. 4. Oogonium with short papillations. 5. Oogonium on coiled stalk; androgynous antheridial branch. 6-13: *Achlya androgyna*. 6, 7. Catenulate, dolioform oogonia, ornamented and smooth; attached monoclinal antheridial branches. 8, 9. Variations in oogonial shape. 10. Papillate, dolioform, intercalary oogonium; subcentric oospores; monoclinal antheridial filaments. 11. Lateral, papillate oogonium. 12. Achlyoid spore discharge. 13. Smooth-walled intercalary oogonia, upper one pyriform, lower one ellipsoidal; prominent wall pitting. Figures 6-9 scale b, all others scale a.



We are transferring *Dictyuchus achlyoides* (Coker and Alexander were designated as its authors by Coker and Matthews, 1937) because the primary sporangia (Fig. 1) are achlyoid. Coker (*loc. cit.*) reported similar sporangia in the material he examined, and in the representatives we have recovered from bogs, the initial sporangia all released spores in an achlyoid manner. The secondary sporangia in some of our specimens are predominantly dictyucoid, but in others, secondarily produced achlyoid ones are equally frequent. Coker (*loc. cit.*) did not, in his very brief discussion of *D. achlyoides*, present arguments for assigning the species to *Dictyuchus*. To be sure, including *D. achlyoides* in *Achlya* distorts the concept of that genus with respect to oospore number; species of *Achlya* may produce oogonia with predominantly but not exclusively one oospore. In our opinion, however, the admission to *Achlya* of species with only one oospore per oogonium modifies generic limits far less than does retention of an achlyoid species (as to discharge pattern) in *Dictyuchus*.

In view of this untraditional change in the taxonomic concept of *Achlya* and *Dictyuchus*, Salvin's (1942) experimental work on sporangium discharge in *Dictyuchus achlyoides* (and *Thraustotheca primoachlya*), becomes particularly noteworthy. He found that achlyoid sporangia in *D. achlyoides* were inhibited (in abundance) more severely than dictyucoid ones when colonies were propagated in staling water. Accordingly, Salvin (1942:103) concluded of *D. achlyoides* that "...the present classification is doubtless the correct one." While it is true that he demonstrated an environmental influence on sporangium development in *D. achlyoides*, the experimental conditions did not eliminate achlyoid primary sporangia. The results of Salvin's work strengthen our decision to assign *D. achlyoides* to *Achlya*, not negate it. Indeed, in several species of *Achlya*, the secondary sporangia are dictyucoid, thraustothecoid, or even aplanoid. The appearance of these types accompanies aging of the culture, a complicated process in which the accumulation of staling products must surely play a part.

SPECIMENS EXAMINED: AUSTRALIA (2). NORWAY (4). UNITED STATES (1), W. C. Coker (preserved specimen; Herbarium University of North Carolina, Chapel Hill. USA.)

Achlya androgyna* (Archer) Johnson and Seymour, *comb. nov.

FIGURES 6-13

Basionym: *Saprolegnia androgyna* Archer, Quart. J. Microscop. Soc. (N.S.) 7:123, pl. 6, fig. 1. 1867.

Achlya braunii Reinsch, Jahrb. Wiss. Bot. 11:284, pl. 14, figs. 1-6. 1878.

Aplanes braunii de Bary, Bot. Zeitung (Berlin) 46:650, pl. 9, fig. 2. 1888.

Saprolegnia treleaseana Humphrey, Trans. Amer. Phil. Soc. (N.S.) 17:111, pl. 17, figs. 56-59. 1893.

Aplanes androgynus (Archer) Humphrey, Trans. Amer. Phil. Soc. (N.S.) 17:134. 1893.

Achlya treleaseana (Humphrey) Kauffman, 8th Rep. Michigan Acad. Sci., Arts, Ltrs. 8:27. 1906.

Achlya acadensis Moore, Proc. & Trans. Nova Scotian Inst. Sci. 12:229, figs. 16-19. 1908-09.

Aplanes braunii var. *mindenii* Shkorbatov, Bot. Mater. Inst. Sporov. Rast. Glavn. Bot. Sada RSFSR 2:36. 1923.

Aplanes treleaseanus (Humphrey) Coker, J. Elisha Mitchell Sci. Soc. 42:217, pls. 34,

35. 1927. [non *Aplanes treleaseanus* (Humphrey) Coker, *Saprolegniaceae*, p. 79, pl. 20. 1923.

Aplanes treleaseanus (Humphrey) Naumova, Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Akad. Nauk SSSR 10:135, fig. 3. 1955.

Aplanes androgynus var. *mindenii* (Shkorbatov) Cejp, Oomycetes I, Flora ČSR, Ser. B, Part 2, p. 271. 1959.

Monococious. Mycelium compact and limited in extent, or diffuse and extensive. Sporangia extremely rare, but formed in special culture conditions; when present, naviculate, fusiform, clavate, or cylindrical; renewed sympodially; 77-988 x 12-42 μm . Spores monomorphic; discharge and behavior achlyoid or aplanoid, very rarely dictyucoid; spore cluster not persisting at exit orifice; primary spore cysts 10-14 μm diam. Gemmae very abundant; fusiform, naviculate, cylindrical, or irregular; occasionally pyriform or obpyriform; branched or unbranched; terminal or intercalary, single or catenulate. Oogonia terminal, intercalary, or lateral; single or catenulate when intercalary; predominantly dolioform, fusiform, or naviculate, occasionally spherical, obpyriform, or cylindrical, rarely irregular or asymmetrical; elongate ones (50-) 105-200 (-508) x (25-) 51-80 (-99) μm , exclusive of wall ornamentations (when present); spherical ones (25-) 70-85 (-94) μm diam., exclusive of wall ornamentations (when present). Oogonial wall pitted; smooth, or densely or sparsely provided with papillate projections; rarely tuberculate, or with one or a few conical spines. Oogonial stalks 1/2-4 times the diameter of the oogonium, in length; straight or curved; isodiametric or slightly irregular in outline; unbranched. Oospores usually subcentric, rarely centric; generally spherical, sometimes angular when crowded; (1-) 8-20 (-40) per oogonium, and usually filling it; (16-) 24-30 (-44) μm diam.; on germination forming a branched hyphal system, or producing a slender, unbranched hypha bearing a small, terminal, fusiform sporangium discharging in an achlyoid, dictyucoid, or aplanoid fashion. Antheridial branches predominantly monoclinal or androgynous, rarely diclinal; sparingly branched or unbranched; usually short, somewhat irregular in outline, persisting. Antheridial cells simple, rarely compound; persisting; unbranched or once-branched; tubular or clavate; generally digitate, very rarely laterally appressed; fertilization tubes usually absent.

DISCUSSION -- In his 1956 monograph, Johnson treated as *Achlya treleaseana* a taxon previously assigned to *Aplanes*. A nearly identical species, except for the absence of oogonial wall ornamentations, is Reinsch's (*loc. cit.*) *Achlya braunii*; Johnson excluded this taxon from *Achlya* because he thought it a member of *Aplanes*. A third species, remarkably similar to *A. treleaseana* and *A. braunii*, is *Saprolegnia androgyna* Archer (*loc. cit.*), which Humphrey (*loc. cit.*) had assigned to de Bary's (*loc. cit.*) genus *Aplanes*.

The three species, *androgyna*, *treleaseana*, and *braunii* (irrespective of their supposed generic affinity), share certain prominent morphological features. Foremost among these is a noticeable rarity of sporangia, but when such structures are produced, the primary spores (certainly those in the latter two taxa) behave in an achlyoid or aplanoid manner. Cultures of *treleaseana* and *braunii* form achlyoid sporangia in acid water; it is not known whether Archer's *Saprolegnia androgyna* responds similarly. All three taxa

are identical in their production of fusiform or dolioform, intercalary, pitted oogonia that are usually provided with subtending monoclinous antheridial branches (*sensu* Johnson, 1956: pl. 1, fig. 8i) and a few to many subcentric oospores (Figs. 6, 7, 10, 13). Additionally, representatives of these three species produce some lateral, spherical oogonia (Fig. 11).

The one seemingly consequential difference among *androgyna*, *braunii*, and *treleaseana*, as they have become circumscribed through the years since their discovery, is the nature of the oogonial wall. In *treleaseana* the oogonia generally are papillate, but in the other taxa these cells are smooth. However, there are prominent descriptions that report the presence of smooth oogonia in *treleaseana*, and ornamented ones in *braunii*.

The systematics of the three species with dolioform or fusiform, intercalary oogonia long has been unsettled is because of two problems. The first has its roots in de Bary's own account of *Aplanes*. Although this genus was described formally in 1888, de Bary mentioned it in 1884, and wrote that specimens of it probably were identical with Reinsch's *Achlya braunii*. As to the characteristic on which *Aplanes* was established, *i.e.* the pattern of primary spore behavior, de Bary (*loc. cit.*) simply said that the spores of the species were not motile, but otherwise the characteristics were like those in representatives of *Achlya*. Reinsch (*loc. cit.*) illustrated an empty sporangium and a dictyucoid one for the fungus he described as *Achlya braunii*. In describing *Achlya acadensis* as a provisional new species, Moore (*loc. cit.*) induced his fungus (identical to *Achlya treleaseana* in sex apparatus configuration), to produce achlyoid sporangia on colonies growing in water containing living plants of *Sphagnum* sp. Colonies of the fungus in water without *Sphagnum* developed sporangia whose spores germinated *in situ* (that is, were aplanoid *sensu* de Bary). Shkorbatov (*loc. cit.*) did not illustrate his variety *mindenii* of *Aplanes braunii*, but stated that the sporangia discharged as in *Achlya*, *Dictyuchus*, or *Aplanes*. Following Humphrey's (*loc. cit.*) decision to assign Archer's *Saprolegnia androgyna* to *Aplanes*, Cejp (*loc. cit.*) simply reduced Shkorbatov's taxon to varietal status under *Aplanes androgynus*. Archer (*loc. cit.*) did not see sporangia in the watermold he named *Saprolegnia androgyna*, not surprising in view of their rarity. The evidence on the point of the type of spore discharge is clear: these various taxa with similar sex cell morphologies produce some achlyoid sporangia.

The second problem in the taxonomy of the three taxa *braunii*, *treleaseana*, and *androgyna* is that of the nature of the oogonial wall. Some reports -- for example, Migula (1903:75), do not mention any structural features of the oogonium wall. In other accounts, however, the oogonia are described as papillate or smooth (Johnson, 1956). Reinsch's illustrations of *Achlya braunii* show smooth oogonia, except for one figure that depicts a papillate immature one.

Is there experimental evidence to support our contention that the presence or absence of wall ornamentations is variable and therefore not taxonomically significant? We have manipulated the culture conditions (temperature, pH, and source of water) in attempts to modify the wall configuration of isolates with smooth oogonia (*androgyna-braunii*), and those with ornamented ones (*treleaseana*). Incubation temperatures of 8°, 10°, and 15° C induced colonies of the *treleaseana* type to produce oogonia with smaller and fewer ornamentations than those developed by control specimens propagated at 25-28°

C. The numbers of smooth oogonia developed by colonies at the low temperatures was greater (41%) than in the controls (8%). With one exception, neither temperature nor source of water (distilled, pond, stream, or soil extract; all unbuffered, pH 4.3, 6.8, 8.1, respectively) induced isolates of the *androgyna-braunii* type to form papillate oogonia. At 10° C some colonies propagated in acidified, autoclaved, soil extract produced sparsely crenulate oogonia. The scanty experimental evidence at hand thus is indicative, but is not conclusive that ornamentation may be environmentally modified.

SPECIMENS EXAMINED: -- ICELAND (2), NORWAY (6), SWEDEN (55), UNITED STATES (17). CBS (1). Courtesy of M. W. Dick (2).

Achlya irregularis (Coker and Ward) Johnson and Seymour, *comb. nov.*

FIGURES 14-17

Basionym: *Thraustotheca irregularis* Coker and Ward, in Ward, J. Elisha Mitchell Sci. Soc. 55:348, pl. 31. 1939.

Monoecious. Mycelium dense; hyphae slender, branched. Sporangia cylindrical, fusiform or clavate, occasionally irregular; straight, curved, bent, or branched; renewed sympodially, cymosely, or in basipetal succession; extremely variable in size. Spores monomorphic; discharge and behavior achlyoid in primary sporangia, but thraustothecoid, achlyoid, dictyucoid, or aplanoid in secondary ones; wall of achlyoid sporangia eventually deliquescing in whole or part; primary spore cysts 9-14 µm diam. Gemmae abundant; spherical, pyriform or obpyriform, oval, clavate, or fusiform; terminal or intercalary, single or catenulate. Oogonia lateral, rarely terminal or intercalary; obpyriform, oval, or infrequently spherical; (20-) 40-55 (-72) µm diam. Oogonial wall pitted; smooth. Oogonial stalks (1/2) 1-1 1/2 (-3) times the diameter of the oogonium, in length; stout, straight, curved, or slightly irregular; usually tapering to a narrow base from a wide distal end; unbranched. Oospores frequently aborting, or oospheres not maturing; eccentric when mature; spherical; (1-) 4-8 (-14) per oogonium, but usually not filling it; (10-) 18-22 (-38) µm diam.; germination not observed. Antheridial branches declinuous; long, slender, irregular, and usually sparingly branched; occasionally partially clasping the oogonium or winding loosely about it; persisting. Antheridial cells simple or compound; tubular, clavate; moderately to sparsely branched or unbranched, often long, twisted, and irregular, or long-cylindrical and clasping the oogonium; persisting; attached in a digitate fashion or laterally appressed; fertilization tubes not observed.

DISCUSSION -- Coker and Ward (Ward, *loc. cit.*) were explicit in their account that the primary sporangia of this species were achlyoid. We find the same to be true (Fig. 14) in the specimens we have examined. While the secondary sporangia of our isolates were largely thraustothecoid, achlyoid ones were not eliminated through repeated subculturing. Accordingly, we are transferring *Thraustotheca irregularis* to *Achlya*.

Assignment of this species to *Achlya*, however, may not be the final disposition of the taxon. Coker and Ward were careful to note that the achlyoid sporangia produced by their fungus deliquesced entirely or in part after the spores were released. Our specimen did not display such a feature, but if it is characteristic of other representatives of the species, there would then be further evidence for the very close kinship of *Achlya* and

Thraustotheca. If emptied sporangia of the *Achlya* type deliquesce, as in *Thraustotheca*, are they properly to be considered achlyoid?

Coker and Ward (Ward, *loc. cit.*) found that their *Thraustotheca irregularis* would produce sexual structures only when the mycelium was cultured on small bits of hempseed, or on nutrient-poor substrates. We have not seen this to be a necessary prerequisite for sex cell formation in our isolate. In any event, we are not certain that a small segment of a hempseed is *a priori* a nutrient-depleted substratum.

SPECIMENS EXAMINED: -- CENTRAL AMERICA (1), SOUTH AMERICA (2), UNITED STATES (2).

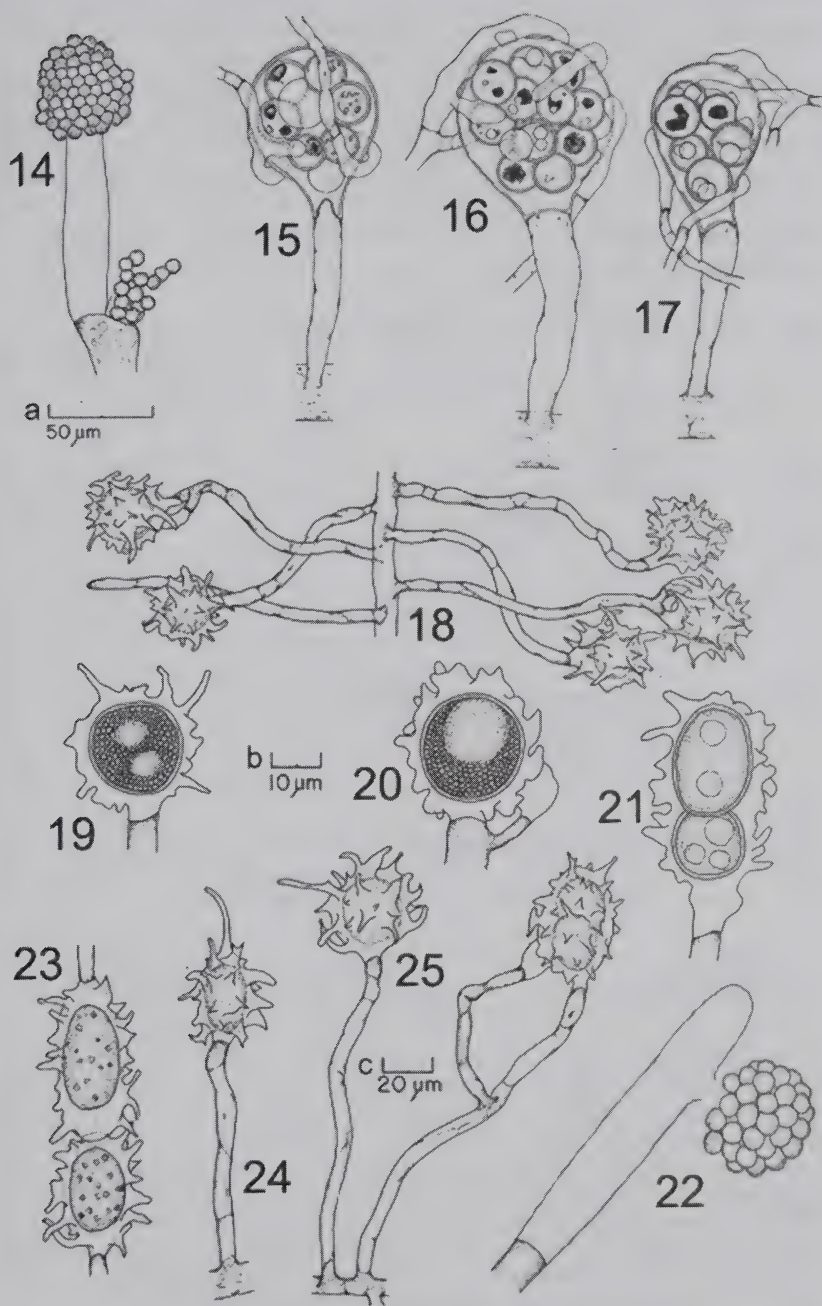
Achlya ornata Johnson and Seymour, *nom. nov.*

FIGURES 18-25

Basionym: *Aplanopsis spinosa* Dick, Trans. Brit. Mycol. Soc. 43:60, pl. 2, text figs. 1, 2. 1960, non *Achlya spinosa* de Bary, Bot. Ztg. 1882: 167. 1882.

Monoecious. Mycelium extensive; hyphae slender, flaccid, slightly irregular and sinuous, and frequently branched, often sympodially from below hyphal tips. Sporangia extremely rarely produced, then very sparse, appearing on early formed hyphae, and then quickly evanescent; cylindro-fusiform or cylindrical; method of renewal unknown; 100-135 x 20-25 μ m. Spores monomorphic; discharge and behavior achlyoid; exit pore terminal or lateral; spore cluster falling away readily from exit orifice; primary spore cysts 10-12 μ m diam. Gemmae lacking. Oogonia lateral, occasionally intercalary and single or catenulate, rarely terminal; spherical or subspherical, broadly ellipsoidal or dolioform when intercalary; infrequently ovoid or with an elongate, tubular apiculus; (17-) 30-40 (-67) μ m diam., including wall ornamentations. Oogonial wall densely ornamented with apically rounded or mammiform papillae, truncate or conical cylindrical projections that are straight, curved, or faintly hamate; wall extensions sometimes lobed or inconspicuously indented; thin, unpitted. Oogonial stalks (2-) 3-4 (-9) times the diameter of the oogonium, in length; slender, flaccid, slightly twisted or irregular; unbranched or rarely once-branched; often arranged in a racemose manner on the slender principal hyphae. Oospores subcentric; spherical, oval or ellipsoidal; 1 (-4) per oogonium and usually filling it; (10-) 16-24 (-42) μ m diam.; at germination forming a slender, sinuous, branched or unbranched germ hypha. Antheridial branches, when present, androgynous, or antheridial apparatus hemihypogynous; short, slender, irregular; persisting. Antheridial cells simple; clavate or irregularly bulbous; persisting; apically appressed; fertilization tubes present but obscured by wall ornamentations, apparently persisting.

FIGS. 14-25. *Achlya irregularis* and *Achlya ornata*. 14-17: *Achlya irregularis*. 14. Terminal, achlyoid secondary sporangium, and partially emptied subterminal one. 15-17. Lateral, obpyriform oogonia with attached antheridial branches; wall conspicuously pitted; oospores mature or in stages of disintegration. 18-25: *Achlya ornata*. 18. Characteristic configuration of long-stalked, densely spiny oogonia. 19. Oogonium with irregularly ornamented wall, and immature oospore. 20. Optical section of oogonium with papillate wall protrusions, a subtending antheridial branch, and subcentric oospore. 21. Terminal oogonium. 22. Sporangium with lateral achlyoid discharge of encysted spores. 23. Intercalary oogonia. 24, 25. Variations in appearance of oogonial wall ornamentations. Figure 14 scale a, 15-18, 22-25 scale c, 19-21 scale b.



DISCUSSION -- Ordinarily, it is impossible to distinguish among species of watermolds by the macroscopic appearance of the colony in water. *Achlya ornata* is one of few exceptions: its mycelium is very diffuse, quite extensive (4-6 cm diam.), and conspicuously flaccid. Dick (*loc. cit.*) assigned his species to *Aplanopsis* because he apparently did not observe sporangia. However, one of the isolates obtained from Dick formed sporangia that were very scanty and quickly evanescent with an achlyoid discharge pattern, and for this reason the species was placed in *Achlya*. As the epithet *spinosa* is preempted by one of de Bary's (1881) species, we are providing the new name, *ornata*, in reference to the dense, variously-shaped oogonial wall projections.

SPECIMENS EXAMINED: -- NORWAY (3). Courtesy of M. W. Dick (2)

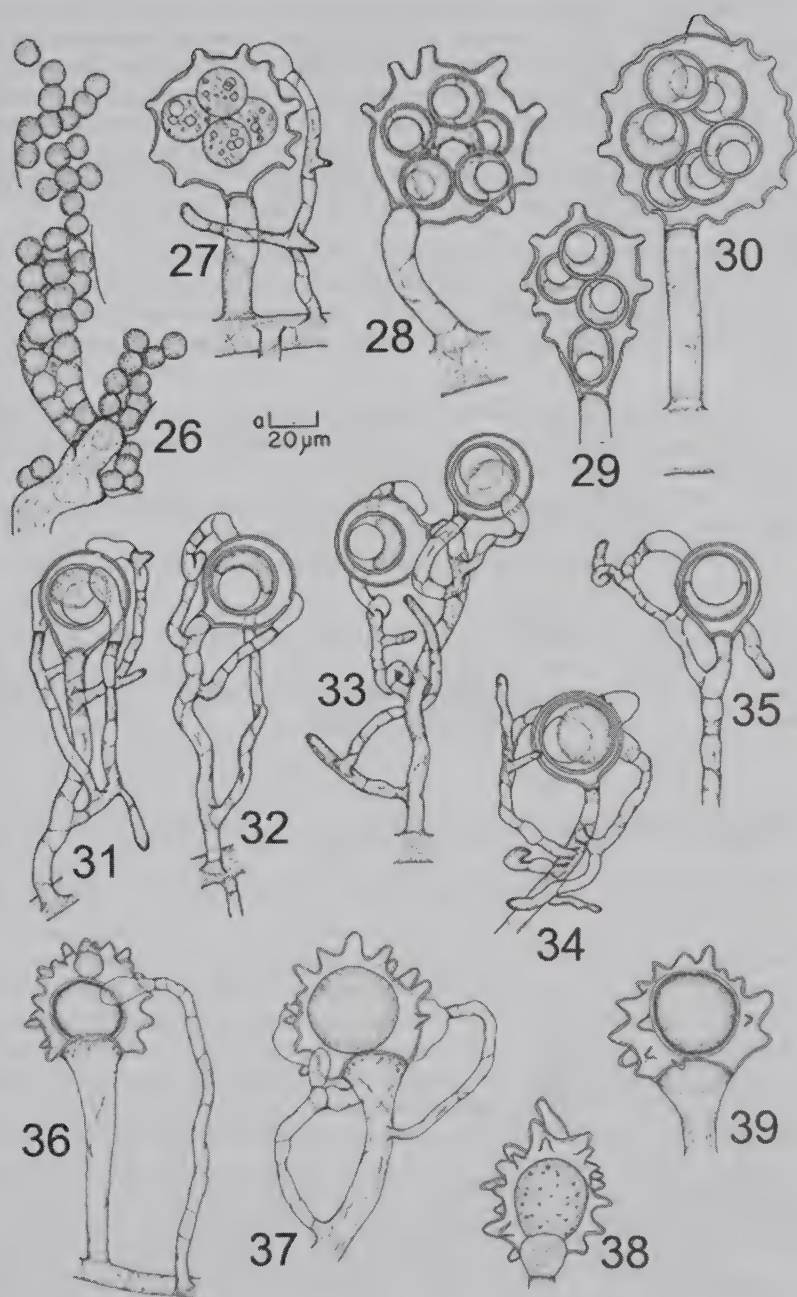
Achlya primoachlya (Coker and Couch) Johnson and Seymour, *comb. nov.*

FIGURES 26-30

Basionym: *Thraustotheca primoachlya* Coker and Couch, J. Elisha Mitchell Sci. Soc. 40:198, pls. 39, 40. 1924

Monoecious. Mycelium dense; hyphae stout, frequently branched. Sporangia very abundant, cylindrical, clavate, fusiform, or naviculate, often irregular or curved, rarely branched; renewed sympodially or cymosely; 90-188 x 12-39 μm ; achlyoid ones may deliquesce shortly after spore release. Spores monomorphic; discharge and behavior achlyoid from primary sporangia, thraustothecoid or achlyoid from secondary ones; primary spore cysts 9-12 μm diam. Gemmae lacking. Oogonia lateral, rarely terminal; spherical or oval; (28-) 55-68 (-84) μm diam., including wall ornamentations. Oogonial wall unpitted, but thin at apex of some wall projections; provided sparsely or densely with conspicuous papillae that are rounded or nearly truncate at the apex, or with crenulate protuberances. Oogonial stalks (3/4-) 1 - 1 1/2 (- 3) times the diameter of the oogonium, in length; stout, straight or curved, but not recurved; only very slightly irregular; unbranched. Oospores eccentric; spherical; (1-) 4-8 (-20) per oogonium, and generally not filling it, (16-) 20-24 (-29) μm diam.; at germination forming a short, slender germ hypha, usually penetrating the oogonial wall through a projection, and bearing a small, terminal, subclavate sporangium of the achlyoid or thraustothecoid type, or forming a germ tube only or endogenous spores without first developing a sporangium. Antheridial branches sparse; androgynous or monoclinal, but often not attached to an oogonium; slender and usually irregular or somewhat twisted and gnarled; short or long; branched or unbranched; not persisting. Antheridial cells simple; tubular or clavate; persistent; laterally appressed; fertilization tubes not observed.

FIGS. 26-39. *Achlya primoachlya*, *Achlya pseudoachlyoides*, and *Protoachlya benekei*. 26-30: *Achlya primoachlya*. 26. Release of encysted spores by sporangial wall dissolution. 27. Papillate oogonium and attendant monoclinal antheridial branch; wall characteristically thin (pitted) at end of truncate-papillate protrusions. 28-30. Variations in oogonial shape and prominence of wall extensions; oospores eccentric. 31-35: *Achlya pseudoachlyoides*. 31-35. Obpyriform and spherical oogonia, and attached androgynous antheridial branches; oospores eccentric. 36-39 *Protoachlya benekei*. 36. Lateral oogonium and monoclinal antheridial branch; oospore centric; stalk characteristically expanded immediately below oogonium. 37. Immature oogonium; antheridial cells attached laterally or apically to oogonial wall. 38. Terminal, papillate oogonium; hypha flared at apex. 39. Oogonium on a flared stalk; oospore centric. All figures same scale



DISCUSSION -- Both in the original description and discussion of *Thraustotheca primoachlya* the primary sporangia were said to be achlyoid in the manner of discharge (Coker and Couch, *loc. cit.*), and this was the case with our specimens. Spore release from secondary sporangia, on the other hand, was thraustothecoid or achlyoid, with the latter becoming less frequent as the colony ages. Moreover, when the oospores germinated, the resulting sporangia also were either achlyoid or thraustothecoid in the release of spores. A rather peculiar aspect of the primary achlyoid sporangia is that they may deliquesce (in some individuals) shortly after the spores are released.

Because the primary sporangia are consistently achlyoid in their behavior at dehiscence, we are transferring *Thraustotheca primoachlya* to *Achlya*. In this connection it may be noted that Green and Dick (1972) judged that their determinations of DNA base pair compositions (GC percentages) were supportive of an assignment of *T. primoachlya* to *Achlya*.

Salvin (1942) experimented with *Thraustotheca primoachlya* in a study of the effect of culture conditions on the spore release pattern in certain water molds. He found that regardless of the particular culture environment, the mycelium of the isolates produced only achlyoid sporangia at first. Later, as the culture water became more foul, the frequency of achlyoid discharge declined, and thraustothecoid release predominated or occurred exclusively. We suggest that these findings support our decision to transfer *T. primoachlya* to *Achlya*.

In their account of *Thraustotheca primoachlya*, Coker and Couch (1924:197) suggested that the sporangial behavior in this species could be "... considered as the 'youth form'...", and pointed to "... *Achlya* as the ancestor of *Thraustotheca*." Sorenson (1962) thought that *T. primoachlya* might be an intermediate species.

SPECIMENS EXAMINED: -- UNITED STATES (3). Courtesy of M. W. Dick (1).

Achlya pseudoachlyoides* (Beneke) Johnson and Seymour, *comb. nov.

FIGURES 31-35

Basionym: *Dictyuchus pseudoachlyoides* Beneke, J. Elisha Mitchell Sci. Soc. 64:263, pl. 30. 1948.

Monoecious. Mycelium extensive, dense; hyphae slender, moderately branched. Sporangia cylindrical or clavate, usually slightly curved or sinuous; renewed sympodially or cymosely; 93-562 x 14-32 μ m. Spores monomorphic; discharge and behavior achlyoid from primary sporangia, achlyoid, dictyucoid, or rarely aplanoid from secondary ones; primary spore cysts 10-13 μ m diam. Gemmae usually abundant; spherical, oval, or cylindrical; single or catenulate, generally intercalary, and often developed immediately below a sporangium. Oogonia lateral; spherical or obpyriform, infrequently subspherical; (22-) 28-32 (-48) μ m diam. Oogonial wall sparingly pitted or unpitted; smooth. Oogonial stalks (2-) 2 1/2-3 1/2 (-8) times the diameter of the oogonium, in length; slender, irregular, upright or recurved; unbranched or once-branched, but not forming oogonia in a glomerulus; oospores eccentric; spherical; single, and not filling the oogonium or nearly so; (17-) 22-28 (-41) μ m diam.; at germination, forming a short, unbranched germ hypha bearing a small, fusiform, achlyoid sporangium, or a branched

germ hypha producing mycelium directly. Antheridial branches androgynous, very rarely monoclinal; slender, irregular, twisted, branched or unbranched; persisting; occasionally reverting to the production of sporangia or oogonia. Antheridial cells simple; small, tubular or irregular, often curved or sharply bent; persisting; laterally or apically appressed; fertilization tubes not observed.

DISCUSSION -- The primary sporangia of *Dictyuchus pseudoachlyoides* were invariably achlyoid in their discharge in all the living specimens we examined, and Beneke (*loc. cit.*) so described them in the original report. Secondary sporangia commonly are either predominantly achlyoid or dictyucoid in their manner of spore release, and in our isolates, at least one type did not disappear as the culture aged. Thus, there is ample structural evidence for assigning Beneke's species to *Achlya*. This merger further alters the traditional concept of *Achlya*, such that species with only one oospore per oogonium are now included in the genus.

SPECIMENS EXAMINED: -- UNITED STATES (2). Courtesy of E. S. Beneke (subculture and preserved specimen of type).⁸

Protoachlya benekei (Furtado) Johnson and Seymour, *comb. nov.*

FIGURES 36-39

Basionym: *Achlya benekei* Furtado, Rickia 2: 122, figs. 1-10. 1965.

Monoecious. Mycelium dense, limited; hyphae slender, moderately branched. Sporangia sparse; clavate, cylindrical; straight, curved, or bent; exit papilla prominent; renewed sympodially, infrequently in a cymose manner; 96-233 x 18-28 μ m. Spores dimorphic; at discharge behaving in an achlyoid manner, but with many spores grouping only in an irregular, undefined clump and soon swimming away, but others encysting or swimming away immediately from exit orifice in a saprolegnoid fashion and then encysting; motile during discharge; primary spore cysts 10-11 μ m diam. Gemmae sparse; spherical, subglobose, broadly ovoid, or short-cylindrical; terminal or intercalary, single or catenulate. Oogonia lateral or terminal; spherical to subspherical or faintly hemispherical, occasionally broadly ovoid; (50-) 66-75 (-83) μ m diam., including wall ornamentations. Oogonial wall unpitted; provided moderately densely or sparsely with papillate to short-cylindrical ornamentations. Oogonial stalks (1/3-) 2-3 times the diameter of the oogonium, in length; stout, straight or curved; isodiametric or flaring outward conspicuously at the junction with the oogonial wall; unbranched. Oospores centric; spherical or broadly oval; (1-) 2-3 (-6) per oogonium, and often nearly filling it; (10-) 30-40 (-45) μ m diam.; germination not observed. Antheridial branches androgynous or monoclinal; slender, generally irregular; infrequently branched; persisting. Antheridial cells simple; short-clavate to large and irregular; persisting; laterally appressed; fertilization tubes not observed.

DISCUSSION -- The spores of *Protoachlya benekei* behave in exactly the same fashion as those produced by *P. mucronata* (and other *Protoachlyas*). The spores are motile at release, some encysting in an ill-defined clump at or near the exit orifice, while others behave in a saprolegnoid manner. All functional spores are dimorphic.

SPECIMENS EXAMINED: -- SOUTH AMERICA (1), RLS. M. W. Dick (1).

Protoachlya hypogyna (Coker & Pemberton) Johnson & Seymour, *comb. nov.*

FIGURES 40-50

Basionym: *Achlya hypogyna* Coker and Pemberton, Bot. Gaz. (Crawfordsville) 45: 194, figs. 1-6. 1908.

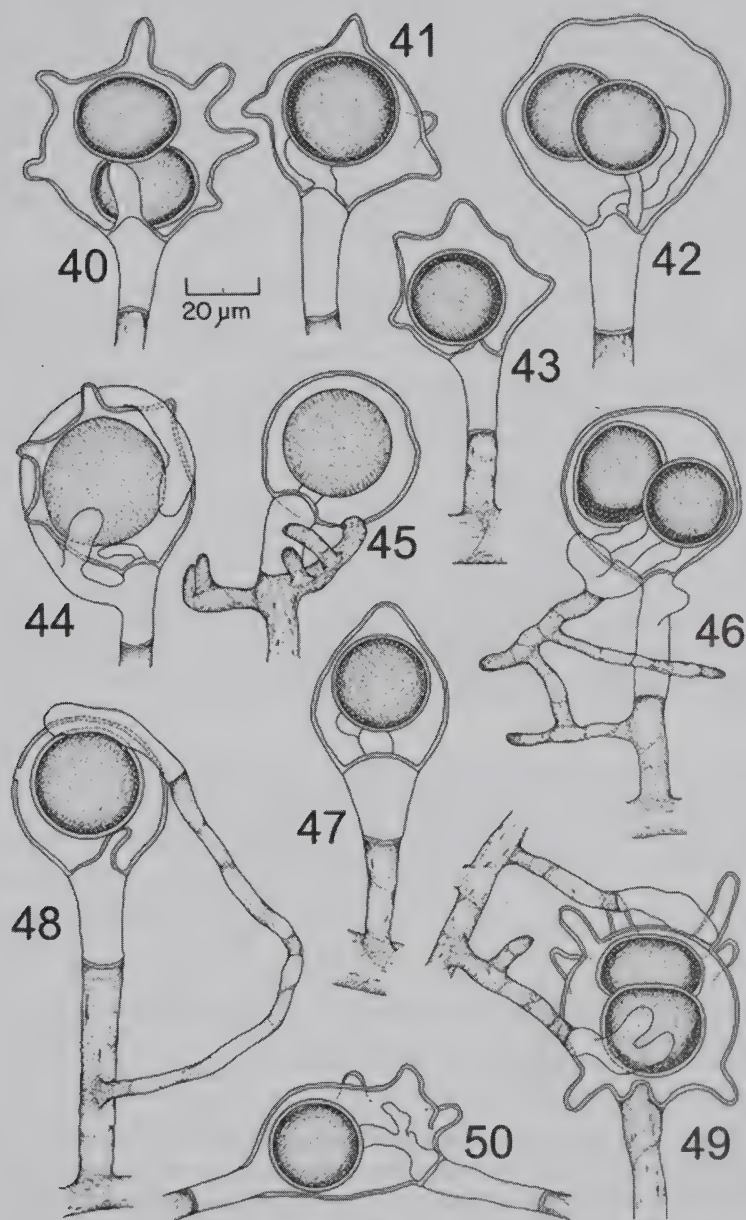
Protoachlya hypogyna Shanor and Conover, Amer. Midl. Naturalist 28:748, pl. 1. 1942. (coincidental epithet)

Monoecious. Mycelium limited, dense; hyphae slender, sparingly to moderately branched. Sporangia narrowly cylindrical to clavate, usually irregular, and occasionally strongly curved distally; discharge papilla prominent; renewed sympodially, in a cymose or a basipetal manner, and occasionally internally; 81-603 x 12-43 μm . Spores dimorphic; at discharge some, most, or all swimming from the orifice, or some encysting after release, and remaining in a loose, undefined clump in the region of the exit pore; rarely released in a dictyocoid or aplanoïd fashion; primary spore cysts 10-12 μm diam. Gemmae spherical, obpyriform, or cylindrical; terminal or intercalary, single or catenulate. Oogonia lateral, infrequently terminal or sessile, rarely intercalary and single or catenulate; spherical, subspherical, obpyriform, broadly apiculate, obovate, ovate, or angular; (20-) 40-50 (-90) μm diam., exclusive of wall ornamentations. Oogonial wall unpitted or rarely very sparsely pitted; smooth or provided sparsely with papillate or cylindro-conical projections, or merely sparsely crenulate; smooth or roughened on inner surface. Oogonial stalks (1/8-) 1/2-1 (-1 1/2) times the diameter of the oogonium, in length; stout, straight or curved; sometimes faintly irregular. Oospores centric or subcentric; spherical, ellipsoidal, or oval, sometimes pyramidal or flattened at one side the result of mutual pressure; (1-) 2-6 (-12) per oogonium, and usually not filling it; (18-) 26-32 (-45) μm diam.; at germination forming a slender, unbranched germ hypha bearing a small, terminal sporangium. Antheridial apparatus usually consisting of hypogynous or hemihypogynous cells, or of androgynous or monoclinalous, or rarely declinalous antheridial filaments; antheridial branches moderately stout; usually short, often irregular and sparingly branched; persisting. Antheridial cells simple; clavate or tubular, unbranched, lobed, or branched; persisting; laterally or apically appressed; fertilization tubes present, persisting.

DISCUSSION – There is no evidence from the morphology of the sexual cells of *A. hypogyna* and the *Protoachlya hypogyna* of Shanor and Conover to contest our claim that the two are synonymous. Accounting for alleged differences in spore behavior and sporangium renewal, however, is critical to the merger of the two taxa.

In the original account of *Achlya hypogyna*, Coker and Pemberton (*loc. cit.*) illustrated the primary spores as biflagellate cells on emergence, and in Coker's later (1923) description of the species he called attention to the similarity in appearance of the sporangia of *A. hypogyna* to those in his *Protoachlya paradoxa*. In the description

FIGS. 40-50. *Protoachlya hypogyna*. 40. Papillate oogonium, centric oospores, hypogynous antheridial cell. 41. Sparsely papillate oogonium, subcentric oospore, hypogynous antheridial cell. 42-48. Variations in shape and degree of oogonial wall ornamentation; hypogynous antheridial cell and fertilization tubes prominent. 49. Papillate oogonium with attached declinalous antheridial branches; no hypogynous antheridial cell. 50. Intercalary oogonium. All figures same scale.



of *P. paradoxa*, however, Coker (1923:90) wrote that some sporangia were renewed internally as occurs in species of *Saprolegnia*, and certainly Shanor and Conover (*loc. cit.*) noted this for their *P. hypogyna*. In the cultured specimens we examined, sporangia were renewed just as described for *Protoachlya* species, and the emerging spores were equipped with flagella. We reexamined the single existing type specimen (preserved) of *A. hypogyna*, and are satisfied that the sporangia displayed are identical (shape and prominent terminal papilla) to those produced by *P. hypogyna*. We found no convincing evidence of internal sporangium renewal in the mycelium on the type slide. It is indeed curious that Coker (1923:104-106) did not assign *A. hypogyna* to his genus *Protoachlya* when he obviously saw cases of spore behavior in *A. hypogyna* exactly like those encountered in *P. paradoxa*.

Equally curious is Johnson's (1956) retention of *Achlya hypogyna* in *Achlya*, and his statement that the type specimen of this species, his isolate from Michigan, and *P. hypogyna* (seen as living material) were not synonymous. We have again examined the only two preserved specimens of Johnson's collection of *A. hypogyna* still in existence, and are now satisfied that on one point at least, he did not describe the fungus precisely. All of the sporangia in the preserved material of this *A. hypogyna* are clavate, and each has a noticeable exit pore at the end of a prominently raised exit papilla. Such sporangia are identical to those we find in *Protoachlya hypogyna*. None of the sporangia in Johnson's material shows internal proliferation, and notes taken on spore discharge at the time the isolate was characterized do not mention spore behavior. From our study of *P. hypogyna*, we recognize that isolates often display a basically achlyoid spore discharge pattern. However, the emerging spores seldom cluster as compactly as is expected of an *Achlya*, and they are flagellate on discharge. Johnson simply failed to study spore discharge critically; and Ziegler (1948) was correct in concluding that the *A. hypogyna* of Coker and Pemberton was synonymous with *P. hypogyna* Shanor and Conover.

Dick (1969) wrote that *Achlya hypogyna* might represent an aggregate species, that is, one defined so broadly as to include three other valid ones (*Protoachlya hypogyna*, *A. mucronata*, and *A. benekei*). We disagree with Dick's aggregate concept because of the very different sporangial behavior patterns among these taxa.

SPECIMENS EXAMINED: -- UNITED STATES (2). W. C. Coker (preserved type of *A. hypogyna*).
CENTRAL AMERICA (1). Courtesy of M. W. Dick (1).

Protoachlya mucronata* (Ziegler) Johnson and Seymour, *comb. nov.

FIGURES 51-56

Basionym: *Achlya mucronata* Ziegler, Mycologia 50: 403, figs. 1-8. 1958.

Achlya stellata var. *multispora* Rai and Misra, Curr. Sci. 46:28. 1977.

DISCUSSION -- Monoecious. Mycelium extensive, moderately dense; hyphae moderately stout, sparingly branched. Sporangia sparse; short- or long-cylindrical to long-clavate, straight or irregular; apical exit papilla not prominent; renewed sympodially or in basipetal succession; 106-703 x 15-28 μ m. Spores dimorphic; at discharge behaving in an achlyoid manner, but with spores grouping in an irregular,

undefined clump, and some soon swimming away but others encysting, or swimming away immediately from the orifice in a saprolegnoid fashion and then encysting; motile during discharge; primary spore cysts 9-12 μm diam. Gemmae sparse; obpyriform to dolioform; terminal or intercalary, usually single. Oogonia lateral, infrequently terminal or intercalary; spherical to obovoid or oval, broadly dolioform when intercalary; (23-) 30-40 (-66) μm diam., exclusive of wall ornamentations. Oogonial wall unpitted; usually provided moderately with short or long papillae and elongate cylindro-conical ornamentations, occasionally only sparsely ornamented; projections straight or curved. Oogonial stalks (1/2-) 1-2 1/2 (-4) times the diameter of the oogonium, in length; stout or slender, straight, curved, or irregular; unbranched, or occasionally sparingly branched. Oospores centric or subcentric, occasionally containing a conspicuous pellucid spot; usually broadly oval, asymmetrical, or broadly ellipsoidal, occasionally spherical; 1-2 (-5), and usually not filling it; (20-) 24-30 (-39) μm diam.; at germination forming a short, stout germ hypha bearing a small, terminal sporangium. Antheridial branches generally monoclinal, infrequently or occasionally androgynous and declinal as well; slender, usually irregular; not persisting. Antheridial cells simple; tubular or clavate, and often irregularly so; persisting; laterally or apically appressed; fertilization tubes not observed.

Because of its protoachlyoid spore discharge pattern, this species must be removed from *Achlya*. The spores of *Protoachlya mucronata* emerge as flagellated cells, and then may behave basically as in *Achlya* species except that the encysted spores do not aggregate into a compact or hollow sphere or cluster. Alternatively, the planonts may leave the sporangium in a saprolegnoid manner (although moving rather sluggishly) only to encyst in a poorly-defined, loose mass at some distance from the orifice. In a few cases, some of the discharging planonts encyst while others from the same sporangium swim away.

There is no mention in Ziegler's (*loc. cit.*) paper of spore behavior in the two specimens he collected, and he did not illustrate the sporangia, hence there is no direct evidence that his water molds were protoachlyoid. However, the very close resemblance in sexual apparatus configuration among the specimens he described and the ones we have examined convinces us that these fungi represent a single species.

Spore behavior in *Protoachlya mucronata* may be difficult to determine because the sporangia are very sparse (developing in very young cultures, then being quickly masked by the growing mycelium). Moreover, there is much variation in *P. mucronata* in the frequency with which an achlyoid (or pseudoachlyoid) configuration will occur. The full expression of protoachlyoid discharge is rarely observed in standard wet mount preparations under a coverslip.

Provisionally, we are merging *Achlya stellata* var. *multispora* with *P. mucronata* chiefly on the basis of the illustrations published by Rai and Misra (1977) in a separate paper from that in which the variety was first described. We are satisfied that the fungus described by them is not allied to de Bary's *A. stellata*.

SPECIMENS EXAMINED: -- AUSTRALIA (2), OCEANIA (1), UNITED STATES (12).

Saprolegnia itoana* (Nagai) Seymour, *comb. nov.**FIGURES 57-64**

Basionym: = *Isoachlya itoana* Nagai, J. Fac. Agric. Hokkaido Imp. Univ. 32:11, pl. 2, figs. 35-37; pl. 3, figs. 1-8. 1931.

= *Isoachlya subterranea* Dissmann, Beih. Bot. Centralbl. 48:110, figs. 1-7. 1931.

= *Isoachlya glomerata* Richter, Flora 131:241, fig. 4. 1937.

= *Cladolegnia itoana* (Nagai) Johannes, Feddes Repert. Spec. Nov. Regni Veg., p. 213. 1955. = *Cladolegnia subterranea* (Dissmann) Johannes, *ibid.*, p. 213. 1955.

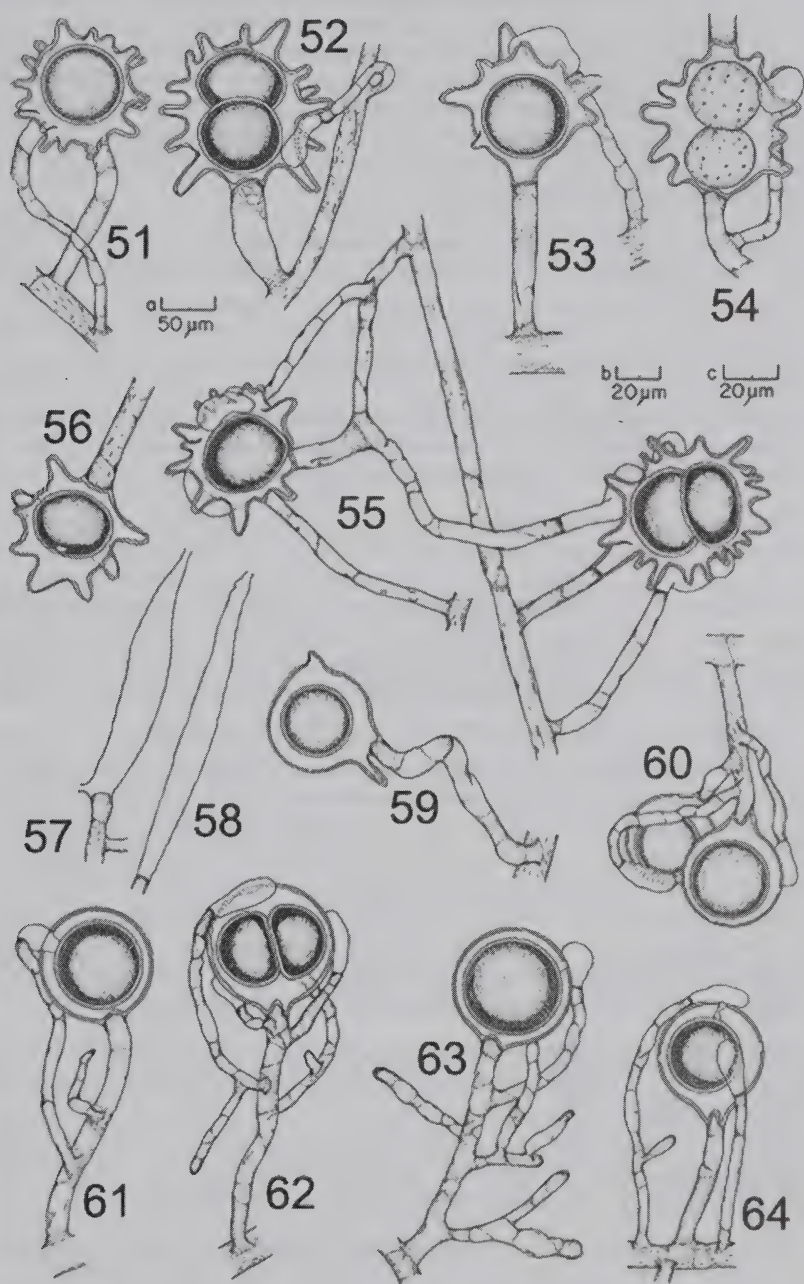
= *Cladolegnia glomerata* (Richter) Johannes, *ibid.*, p. 214. 1955.

= *Saprolegnia subterranea* (Dissmann) Seymour, Nova Hedwigia (Beiheft) 19:59, figs. 146-153. 1970.

Monoecious. Mycelium dense, extensive; hyphae stout, moderately branched. Sporangia fusiform or cylindrical, frequently curved, bent, or irregular, infrequently branched; sometimes having short, lateral protrusions basally; apex usually narrow and tapering; renewed internally or by sympodial branching, internally renewed ones usually formed outside the discharged sporangium; 161-560 x 21-52 μm . Spores dimorphic, or rarely monomorphic; discharge and behavior saprolegnoid, rarely dictyucoid. Gemmae variable in abundance; fusiform, spherical, obpyriform, or irregular; terminal or intercalary, single or catenulate. Oogonia lateral, occasionally terminal, rarely intercalary and single; frequently in clusters on the hyphae; spherical or obpyriform, rarely cylindrical; (19-) 40-50 (-60) μm diam., including any wall projections. Oogonial wall pitted, unpitted, or pitted only under the region of attachment of antheridial cells; smooth; occasionally with one to a few papillate ornamentations. Oogonial stalks (1/4-) 1-3 (-5) times the diameter of the oogonium, in length; straight, curved, bent, or irregular; unbranched or branched and bearing oogonia in a glomerulate fashion. Oospores centric or subcentric; spherical, but ellipsoidal or flattened at one side when crowded in the oogonium; 1 (-2-4) per oogonium and usually nearly filling it; (18-) 30-40 (-46) μm diam.; germinating to form a long, slender, unbranched germ hypha bearing a small, terminal sporangium. Antheridial branches, when present, predominantly androgynous, occasionally monoclinal, infrequently or rarely declinous; when androgynous, arising from any point on the oogonial stalk, and occasionally very short and attached near the oogonial septum; slender, curved or slightly irregular, unbranched or sparingly branched; persisting. Antheridial cells simple; tubular or slightly clavate, sometimes irregular; persisting; laterally appressed, very rarely attached apically or in a digitate fashion; fertilization tubes present in some oogonia, and persisting.

DISCUSSION -- The choice of Nagai's (loc. cit.) *Isoachlya itoana* as the basionym rather than Dissmann's *I. subterranea* is arbitrary. There evidently is no record of

FIGS. 51-64. *Protoachlya mucronata* and *Saprolegnia itoana*. 51-56 *Protoachlya mucronata*. 51, 52; Characteristic oogonia; oospores centric or subcentric; antheridial branches monoclinal. 53. Oogonium with declinous antheridial branch. 54. Immature, intercalary oogonium. 55. Portion of oogonium-bearing hypha; one antheridial branch is both declinous and monoclinal. 56. Terminal oogonium; oospore subcentric, with pellucid spot. 57-64: *Saprolegnia itoana*. 57, 58. Discharged sporangia. 59. Papillate oogonium; centric oospore. 60-64. Variations in configuration of antheridial branches with oogonium to which attached. Figures 57, 58 scale a; 59-60, 62, 64 scale b; 51-56, 61, 63 scale c.



when, in 1931, the individual numbers of volume 48 (Abteilung 2) of the Beihefte zum Botanischen Centralblatt were issued, hence the publication date of Dissmann's paper is unknown. Circumstantial evidence (Merxmüller, communication) suggests that Dissmann's account appeared in the latter part of 1931, but perhaps as early as July 31 of that year. Part 1 of volume 32 of the Journal of the Faculty of Agriculture, Hokkaido Imperial University, carries the issue date August 1931, but Nagai's article is dated July 1931. Since there is at least a date on Nagai's paper but not Dissmann's, we have chosen the former as having priority.

The close proximity of some androgynous antheridial branches in *Saprolegnia itoana* to the oogonium to which they are attached (Fig. 62) is a feature recalling some species of *Pythiopsis*. The same may be said for the strongly tapering configuration of the sporangia (Figs. 57, 58). The spores of *Pythiopsis* species, however, are monomorphic (monoplanetic according to Coker, 1923, and others), as opposed to the dimorphic condition in *S. itoana*. Both Nagai (*loc. cit.*) in describing *Isoachlya itoana*, and Dissmann (*loc. cit.*) in his account of *I. subterranea*, referred to the diplanetic condition, or emergence of two spore types. Accordingly, their species are not assignable to *Pythiopsis* in spite of some obvious similarities with members of that genus.

Although Kelman (1947), who isolated *Isoachlya* (= *Saprolegnia*) *itoana* from North Carolina soils, recognized the similarities between it and Dissmann's (*loc. cit.*) *I. subterranea*, he did not choose to modify the taxonomic status of the two. Somewhat later, Johnson and Surratt (1955) redefined certain species of *Isoachlya*, and reduced Nagai's species to a synonym of Dissmann's taxon. There is no doubt that some specimens identified as Nagai's or Dissmann's species were misidentified, and in reality were representative of *Pythiopsis humphreyana*. This was true, for example, of isolate 569 illustrated by Johnson and Surratt (1955) as figures 14, 16, and 24.

Seymour (1970:59) believed that *Pythiopsis intermedia* Coker and Harvey (Harvey, 1925) was synonymous with Dissmann's *Isoachlya subterranea*, a conclusion certainly supported by Coker and Matthews (1937) who placed *P. intermedia* in *Isoachlya*. We have analyzed the characteristics of a large number of isolates of *Pythiopsis* in comparison with existing descriptive and illustrative matter. We are satisfied that *Isoachlya intermedia* and *Pythiopsis intermedia* were merely new names applied to *Pythiopsis humphreyana*, a valid and recognizable species as Coker (1914) originally thought it to be. Accordingly, the names *Pythiopsis intermedia* and *Isoachlya intermedia* are not considered to be synonymous (Seymour, 1970) with *Saprolegnia itoana*.

In their study of DNA base compositions, Green and Dick (1972) stated that the GC values obtained by them supported Seymour's (*loc. cit.*) removal of *Isoachlya subterranea* to *Saprolegnia*.

SPECIMENS EXAMINED: -- UNITED STATES (14). Cultures from CBS (1) and M. W. Dick (2); localities unknown.

Acknowledgements

We acknowledge the following generous awards which made possible the field and laboratory work as well the preparation of this manuscript: National Science Foundation grant nrs. GB-8693, GB-13404, GB-26638, GB-27297, GB-35661, BMS-72-02352-A01, BMS-75-01155, DEB-76-20123-A01, DEB-0328316; U.S. Atomic Energy Commission contract nr. AT-(40-1)-3556; Office of Naval Research contract nr. 1181(15)NR104-820; Arctic Institute of North America under ONR contract N0014-72-A-0375-0002 (subcontract ONR-441). Ms. Melissa Smith, University of North Carolina at Wilmington Center for Marine Science kindly assisted with electronic formatting of the figures. We are grateful to Dr. Martha Powell, Department of Biology, The University of Alabama, and Dr. Keith Seifert, Agriculture & Agri-Food Canada for their critical reviews of this manuscript.

Literature Cited

- Bary A de. 1881. Untersuchungen über die Peronosporéen und Saprolegnieen und die Grundlage eines natürlichen Systems der Pilze. Abh. Senckenberg Naturf. Ges. 12:225-369.
- Bary A de. 1884. Vergleichende Morphologie und Biologie der Pilze, Mycetozen und Bacterien. Wilhelm Engelmann: Leipzig. 588pp.
- Coker WC. 1914. Two new species of water molds. Mycologia 6:285-302.
- Coker WC, 1923. The *Saprolegniaceae* with notes on other water molds. Univ. North Carolina Press: Chapel Hill, 201 pp.
- Coker WC, Couch, JN. 1924. Revision of the genus *Thraustotheca*, with a description of a new species. J. Elisha Mitchell Sci. Soc. 40:197-202.
- Coker WC, Matthews VD. 1937. *Saprolegniales*. North Amer. Fl. 2 (1):15-67.
- Dick MW. 1969. *Achlya hypogyna* – an aggregate, or a polymorphic species? Mycologia 61:1002-1008.
- Dissmann E. 1931. Zur Kenntnis einer neuen *Isoachlya*-Art aus dem Erdboden. (Neue und wenig bekannte Phycomyceten aus Lunz a. See. I.) Beih. Bot. Centralbl. 48:103-111.
- Green BR, Dick MW. 1972. DNA base composition and the taxonomy of the Oomycetes. Canad. J. Microbiol. 18:963-968.
- Harvey JV. 1925. A study of the water molds and pythiums occurring in the soils of Chapel Hill. J. Elisha Mitchell Sci. Soc. 41:151-164.
- Johnson Jr TW, 1956. The genus *Achlya*: morphology and taxonomy. Univ. Michigan Press: Ann Arbor. 180 pp.
- Johnson Jr TW, Seymour RL, Padgett DE. 2002. Biology and systematics of the *Saprolegniaceae* (online publication accessible at <http://aa.uncw.edu/digilib/biology/fungi/taxonomy%20and%20systematics/padgett/read_first/watermold_treatise_organization.htm>).
- Johnson Jr TW, Surratt J. 1955. Taxonomy of the species of *Isoachlya* possessing single oospores. Mycologia 47:122-129.
- Kelman A. 1947. A rare species of *Isoachlya* found in North Carolina. J. Elisha Mitchell Sci. Soc. 63:207-211.
- Migula W. 1903. Myxomycetes, Phycomycetes, Basidiomycetes (ordn. *Ustilagineae* und *Uredineae*). In, Thomé Flora von Deutschland, Deutsch-Oesterreich und der Schweiz. Pilze 3(1):1-150.
- Nagai M. 1931. Studies on the Japanese *Saprolegniaceae*. J. Fac. Agric. Hokkaido Imp. Univ. 32:1-43.
- Rai JN, Misra JK. 1977. Aquatic fungi from alkaline ponds and soils. Kavaka 5:73-78.

- Salvin SB. 1942. Factors controlling sporangial type in *Thraustotheca primoachlya* and *Dictyuchus achlyoides*. I. Amer. J. Bot. 29:97-104.
- Seymour RL. 1970. The genus *Saprolegnia*. Nova Hedwigia (Beiheft) 19:1-124.
- Sorenson WG. 1962. The *Saprolegniaceae* of Johnson County, Iowa. Master's thesis, Iowa State Univ., Ames. 68 pp.
- Ziegler AW. 1948. A comparative study of zygote germination in the *Saprolegniaceae*. Science 107:506.

Kochmania, a new genus of smut fungi and new records of cypericolous species from Poland and Ukraine

MARCIN PIĄTEK

mpiatek@ib-pan.krakow.pl

*Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences
Lubicz 46 PL-31-512 Kraków, Poland*

Abstract—The new genus *Kochmania* is described to accommodate the smut fungus *Ustilago oxalidis*, and the new combination *Kochmania oxalidis* is proposed. *Schizonella intercedens* is newly recorded from Poland, while *Anthracoidea kari* and *A. sempervirentis* are reported for the first time from Ukraine. A key to *Anthracoidea* species parasitizing representatives of *Carex* sect. *Aulocystis* is provided.

Key words—Ustilaginomycetes, *Oxalis*, sedges, Europe

Introduction

When I worked on the catalogue of Polish smut fungi (Piątek et al. submitted), I discovered some remarkable points concerning taxonomy and geography of several smut fungi. The results of some of them are given and discussed below. The microscopic routine and SEM-studies were made as described in Piątek et al. (submitted).

A new genus for *Ustilago oxalidis*

On the basis of observations which accumulated in the last decade, it has become obvious that representatives of the genus *Ustilago* (Pers.) Roussel are restricted to host plants of the family *Poaceae* (Bauer et al. 1997; Vánky 1999). The species of ‘*Ustilago*’ on other monocotyledonous families have been transferred to other genera, for instance those on *Cyperaceae* and *Juncaceae* to *Bauerago* Vánky (Vánky 1999), and those on *Liliaceae* to *Vankya* Ershad (Ershad 2000). The same situation occurred with ‘*Ustilago*’ on dicotyledons, most of them have been transferred to the genus *Microbotryum* Lév. emend. G. Deml & Oberw., which includes species possessing violet-coloured spores (Vánky 1998a). A small number of ‘*Ustilago*’ on dicots that do not possess violet spores have been transferred to other genera, for instance *Tothiella* Vánky (Vánky 1999), *Yelsemia* J. Walker (Vánky 2002) or *Ahmadiago* Vánky (Vánky 2004). Recently, Vánky (2004) reduced *Tothiella* (single-spored) to synonymy with *Thecaphora* Fingerh. (with spore-balls), but I prefer to keep these genera separate. Similar is the situation in three closely related but independent genera of *Ustilentylomataceae*, viz. *Aurantiosporium*

M. Piepenbr., Vánky & Oberw. and *Fulvisporium* Vánky (both with more or less permanent spore-balls) versus *Bauerago* (single-spored) (Vánky et al. 1997; Vánky 1999).

During my studies, I realized that *Ustilago oxalidis* Ellis & Tracy on *Oxalidaceae* also cannot be included in the genus *Ustilago*. Bauer et al. (2001), in their classificatory system of Ustilaginomycetes, placed this species in the family *Glomosporiaceae* together with *Glomosporium* Kochman, *Thecaphora* and *Tothiella*, and concluded that this species requires transfer to a new genus. Therefore, I am proposing the genus *Kochmania* M. Piątek to accommodate *Ustilago oxalidis*.

***Kochmania* M. Piątek, gen. nov.**

Genus Glomosporiacearum sensu Bauer et al. (2001). Sori in seminibus plantarum familiae Oxalidaceae. Peridium, columella et cellulae steriles deficiunt. Massa sporarum pulverea, rubicundo-brunneae. Sporae singulae, verrucosae, aureo-flavide, colore violaceo et luteo-flavido carentes. Anamorphae praesens in staminibus. Typus generis: Kochmania oxalidis (Ellis & Tracy) M. Piątek.

Etymology: This genus is named in honour of late Professor Józef Kochman (1903–1995), an eminent Polish mycologist, who worked on smut fungi in Poland and published several papers and two monographs concerning this unusual group of fungi. He also described the genus *Glomosporium*, which is the type of the family *Glomosporiaceae* to which the new genus belongs.

KEY CHARACTERS — The genus belongs to the *Glomosporiaceae* (Bauer et al. 2001). Sori in seeds of host plants from the family *Oxalidaceae*. Peridium, columella and sterile cells are lacking. Spore mass powdery, reddish-brown. Spores single, verruculose, golden yellow, without tint of violet or orange yellow. Anamorph present in anthers.

COMMENTS — *Kochmania* differs from all three other genera of *Glomosporiaceae* in some respects. *Glomosporium* and *Thecaphora* include species forming spore-balls, with pale cinnamon-brown spores in the former and light brown spores in the latter. *Tothiella*, with its single species, *T. thlaspeos* (Beck) Vánky does not form spore-balls, but its single spores are light yellowish-brown (Vánky 1999). Hence, the golden yellow colour of spores in *Kochmania* is unique amongst these genera. Finally, these four genera occur on different dicotyledonous families, *Glomosporium* on *Chenopodiaceae*, *Thecaphora* on various dicots (but not on *Brassicaceae*), *Tothiella* on *Brassicaceae*, while *Kochmania* occurs on *Oxalidaceae*.

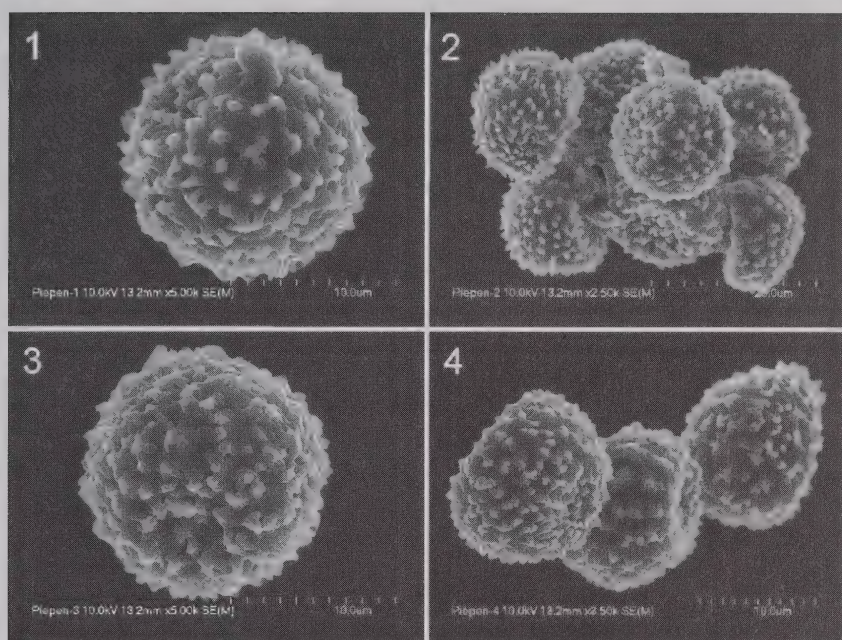
***Kochmania oxalidis* (Ellis & Tracy) M. Piątek, comb. nov.**

FIGURES 1–4

Basionym: *Ustilago oxalidis* Ellis & Tracy, J. Mycol. 6: 77. 1890.

Sori in seeds, filling the capsules with ochraceous or reddish-brown, rather inconspicuous powdery mass of spores, infected capsules are shorter and wider than healthy ones. Spores single, globose, $12\text{--}16 \times 15\text{--}20\ \mu\text{m}$, golden yellow, lacking violet or orange yellow tints, surface densely, irregularly verruculose, warts up to $1\ \mu\text{m}$ high, often anastomosing at the bases. Anamorph present in the anthers.

On *Oxalidaceae*: *Oxalis corniculata* L., *O. fontana* Bunge, *O. stricta* L., world-wide (Vánky 1994).



Figs 1–4. *Kochmania oxalidis*: spores in SEM (KRAM F-3062).

SPECIMENS EXAMINED (SELECTED) — POLAND. WESTERN CARPATHIANS: MUSZYNA, on *Oxalis stricta* L., 20 Aug. 1935, W. Stec-Rouppertowa (KRAM F-3063); **BRAMA KRAKOWSKA:** KRAKÓW-SIKORNIK, on *Oxalis stricta* L., 6 Oct. 1929, W. Stec-Rouppertowa (KRAM F-3062); **KOTLINA SANDOMIERSKA:** MICHAŁÓWKA NEAR PRZEMYŚL, on *Oxalis stricta* L., 5 July 1932, J. Kochman (KRAM F-3060).

A new *Schizonella* for Poland

The genus *Schizonella* J. Schröt. is characterized by sori on leaves of *Cyperaceae* forming black pustulate streaks containing agglutinated spore mass and spores occurring in pairs or larger, irregular groups. Five species are known in this genus, three of them occur on *Carex* – *S. cocconii* (Morini) Liro, *S. intercedens* Vánky & A. Nagler, *S. melanogramma* (DC.) J. Schröt., one on *Kobresia* – *S. elynae* (Blytt) Liro, and another one on *Isolepis* – *S. isolepidis* Vánky. In Poland only two species have been known, *S. melanogramma* and *S. cocconii*. The first of them is fairly common in the country on various species of *Carex*, while the second was recorded only in Wyżyna Lubelska upland, in the eastern part of the country. It must be rare because recent special searches for this species in natural populations of *Carex humilis* Leyss. in Wyżyna Małopolska upland (central Poland) proved unsuccessful.

Revising herbarium specimens from LBLM labelled as *S. melanogramma* I found two collections on *Carex michelii* Host that belong to different species, viz. *S. intercedens*.

These collections have been reported as *S. melanogramma* by Romaszewska-Sařata (1982). *Schizonella intercedens* is a smut fungus new for Poland as follows:

Schizonella intercedens Vánky & A. Nagler

FIGURES 5–9

in Vánky, Mycotaxon 69: 105. 1998b.

Sori on both sides of the leaves as black, hard, pustulate, intraepidermal striae, 1–10 mm long, but often confluent and becoming much longer, in older specimens the epidermal cells burst and release semi-agglutinated mass of spores. Spores in pairs or in small groups of 3–8, but often also single after separating from the groups, single spores elongated, irregular, subangular or hemispherical, olivaceous brown, smooth, (5–)7–9 $\times$ 9–12 μ m, wall up to 0.5 μ m thick.

SPECIMENS EXAMINED — POLAND. WYŻYNA LUBELSKA: MIĘĆMIERZ NEAR KAZIMIERZ, *Inuletum ensifoliae*, on *Carex michelii* Host, 29 May 1980, J. Romaszewska-Sařata (LBLM 8472, 8473).

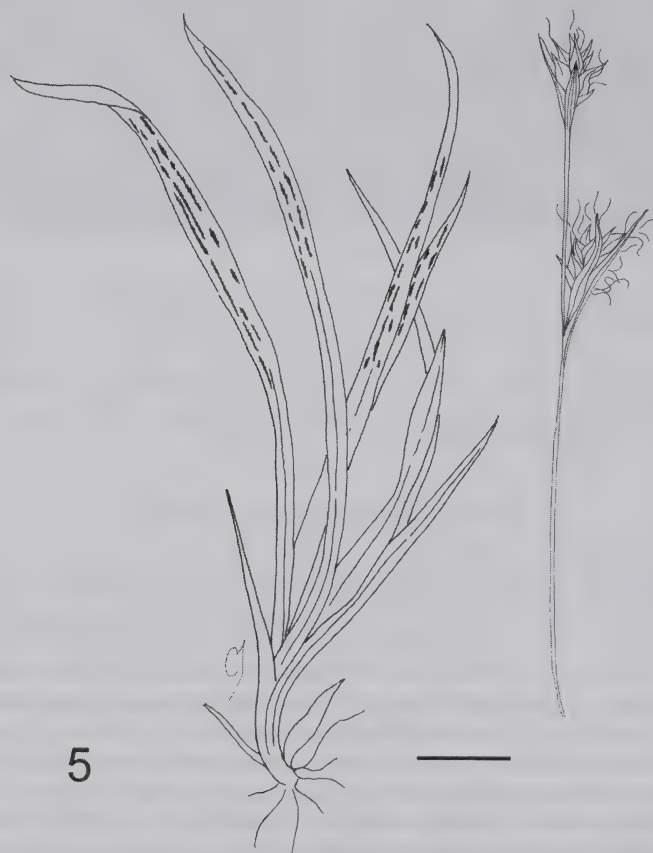
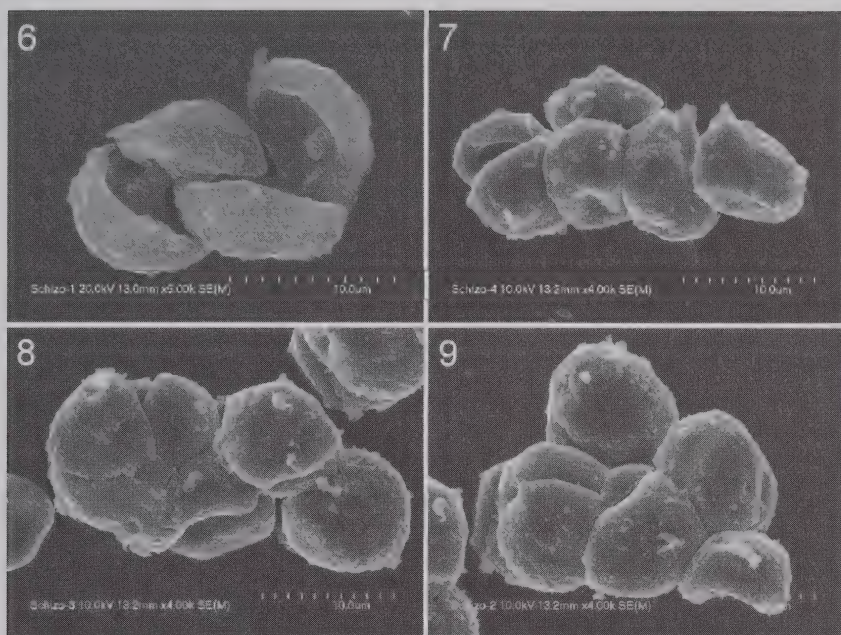


Fig. 5. Sori of *Schizonella intercedens* in the leaves of *Carex michelii* (LBLM 8472). Bar = 1 cm (drawn by J. Cabařa).



Figs 6–9. *Schizonella intercedens*: paired spores and spore-balls in SEM (LBLM 8472).

COMMENTS — *Schizonella intercedens* has been described quite recently as new species segregated from the *S. melanogramma* complex. It differs from the latter by possessing spores in pairs as well as in groups of 3–8. *Schizonella melanogramma* has spores in pairs. The third species of *Schizonella* on *Carex*, *S. cocconii* forms spore-balls composed of 2–20 or more spores. Moreover, all these three species vary in their type of germination, cultures and morphology of basidia and basidiospores (see Vánky 1998b).

The type collection (holotype, isotype and paratype) of *Schizonella intercedens* originates from Hungary, but in the protologue the species is mentioned also from other countries, including Austria, Bulgaria, Czech Republic, Yugoslavia, Romania, and Slovakia (Vánky 1998b). In this situation the location of *S. intercedens* in Poland is the first at the northern border of the Carpathians and represents the northernmost locality. This smut has been hitherto found exclusively on *Carex michelii* and it seems that is strongly host-specific.

Two new *Anthracoidea* for Ukraine

The genus *Anthracoidea* Bref., with about 75 species worldwide, is a group of highly specialized smut fungi growing on *Cyperaceae*, mostly on *Carex*. They form black, globose or ovoid sori in the ovaries of the host plants, with dark brown, ornamented or rarely smooth spores. In the checklist of Ukrainian fungi (Minter & Dudka 1996) only two species of this genus have been mentioned, viz. *Anthracoidea caricis* (Pers.) Bref. emend. Nannf. and *A. subinclusa* (Körn.) Bref., but in this book many records

escaped the attention of the authors, e.g. records of *A. michelii* Vánky by Vánky (1979), *A. capillaris* Kukkonen by Vánky (1985) or several Polish reports from the Ukrainian Carpathians and Podoliya (see Kawecka-Starmachowa 1936; Kochman 1936; Kochman & Majewski 1973). Since the concept of the genus *Anthracoidea* has been greatly changed from the time when Polish authors collected and reported these fungi in the Ukraine, all possible collections should be re-examined.

During my studies on several voucher specimens of *Anthracoidea* preserved in KRAM I found two species which are new to this country. Now this genus is represented in the Ukraine by six species, but it is extremely small number if we compare this with other countries, for instance from Austria 26 species are known (Zwetko 2003), from Poland 20 species (Piątek et al. submitted), and from Slovakia 19 species (Paulech et al. 1997; Lizoň & Bacigálová 1998; Paulech 1998). This number is even larger in northern countries, e.g. from Norway 32 species of *Anthracoidea* are known (Aarnæs 2002).

***Anthracoidea karii* (Liro) Nannf.**

FIGURES 10–12

Bot. Not. 130: 368. 1977.

Sori in ovaries, as subglobose, black, hard bodies, up to 2 mm in diameter. Spores small, reddish-brown, rounded to subcircular, in plane view, $13\text{--}20 \times 9\text{--}17 \mu\text{m}$, with 2–3 internal swellings, and without light-refractive spots, wall up to $2 \mu\text{m}$ thick, surface finely verruculose, rarely nearly smooth, warts rounded, up to $0.1 \mu\text{m}$ high, irregularly spaced.

SPECIMEN EXAMINED — UKRAINE. EASTERN CARPATHIANS:
“SOKÓLSKI” NEAR KOSOWO, on *Carex echinata* Murray, 28 June 1914, A. Wróblewski (KRAM F-2480).

COMMENTS — This collection has been reported by Kawecka-Starmachowa (1936) as ‘*Cintractia caricis* (Pers.) Magn.’, but it matches perfectly with the characters of *Anthracoidea karii*. The species parasitizes various species of *Carex* subg. *Vigneae*, and principal hosts are *Carex brunnescens* Boeck., *C. dioica* L., *C. echinata* Murray, *C. lachenalii* Schkuhr and *C. parallela* Laest. (Nannfeldt 1979).

Anthracoidea karii is known from several countries in Europe, but it is rather rare or even absent in many lowland areas. It has been reported from Austria, Czech Republic, Denmark, Finland, France, Germany, Great Britain (Scotland), Hungary, Island, Italy, Latvia, Norway, Poland, Romania, Slovakia, Sweden, Switzerland (Nannfeldt 1979; Paulech 1998) and now from Ukraine. It seems that most often it occurs in northern Europe and mountainous areas of Central Europe.

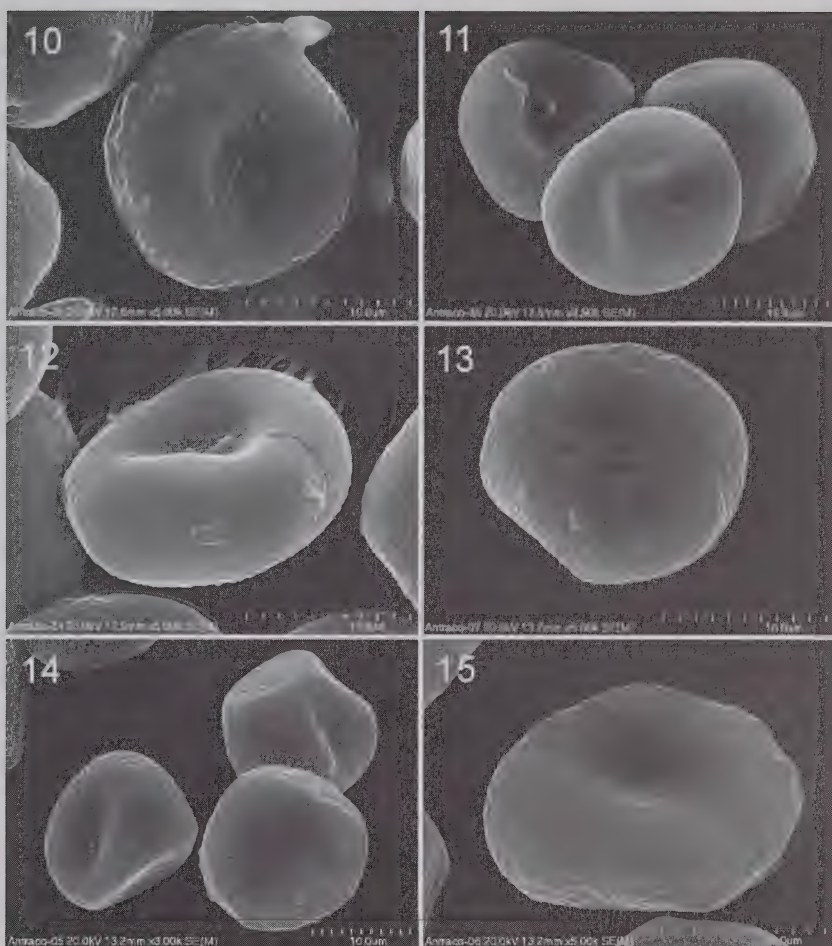
***Anthracoidea sempervirentis* Vánky**

FIGURES 13–15

Bot. Not. 132: 225. 1979.

Sori in ovaries, as subglobose to ovoid, black, hard bodies, up to 2 mm in diameter. Spores medium-sized, dark reddish-brown, rounded, moderately polygonal to irregular, in plane view $15\text{--}22 \times 19\text{--}25 \mu\text{m}$, without internal swellings, but sometimes with light-refractive spots, wall up to $2 \mu\text{m}$ thick, and up to $4 \mu\text{m}$ thick at the angles, surface finely verruculose, warts rounded, up to $0.5 \mu\text{m}$, irregularly spaced or confluent.

SPECIMENS EXAMINED — UKRAINE. EASTERN CARPATHIANS:
Chornohora Mts, KIZIE UŁOHY, elev. ca. 1860 m, on *Carex sempervirens* Vill., 8 Aug. 1935, A. Šrodoň (KRAM F-54089, F-54090).



Figs 10–12. *Anthracoidea kariii*: spores in SEM (KRAM F-2480).

Figs 13–15. *Anthracoidea sempervirentis*: spores in SEM (KRAM F-54090).

COMMENTS — These collections have never been reported before (the collection KRAM F-54090 was only mentioned as source for SEM-micrographs by Piątek et al. submitted). Originally the host in both cases was determined as '*Carex tristis*', but this sedge occurs only in the Caucasus, while in the Carpathians its close counterpart *Carex sempervirens* Vill. is known. *Anthracoidea sempervirentis* occurs on representatives of *Carex* sect. *Aulocystis* (see below in the key).

The geographical range of *Anthracoidea sempervirentis* includes only mountains of Central and Southern Europe, where this smut fungus has been reported from Austria, Bulgaria, France, Germany, Greece, Italy, Poland, Romania, Slovakia, Spain, Switzerland, and former Yugoslavia (Vánky 1979), and now Ukraine is added to this

list. Braun (1999) reported *A. sempervirentis* on *Carex stenocarpa* Turcz. ex V. I. Krecz. from the Mongolian Altai, but this record actually represents *A. stenocarpae* Chleb. (below).

Members of *Carex* sect. *Aulocystis* are infected by five species of *Anthracoidea*. Three of them, *A. altera* Nannf., *A. misandrae* Kukkonen, and *A. sempervirentis* are firmly rooted in the mycological literature since the 1960s and 1970s (Kukkonen 1963; Nannfeldt 1979; Vánky 1979, 1994). The fourth, *A. nepalensis* Kakish. & Y. Ono, has been described from Nepal (Kakishima & Ono 1988), and is known also from one collection from China (Chlebicki 2002). Finally, Chlebicki (2002) added recently the fifth species, *A. stenocarpae* Chleb. from Thian-Shan (Kazakhstan). It is not excluded that one more species should be described. Uljanishchev (1968) reported '*Cintractia caricis* (Pers.) Magn.' on *Carex tristis* M. Bieb. from the Caucasus. This collection(s) may represent a separate species, but the final conclusion is possible only after examination of voucher specimen(s).

The species of *Anthracoidea* parasitizing *Carex* sect. *Aulocystis* can be identified using the key given below.

Key to *Anthracoidea* species on *Carex* sect. *Aulocystis*

1. Spores polyhedral to irregular, 15–22 × 19–25 µm, wall unevenly thickened, internal swellings absent. On *C. brachystachys*, *C. bulgarica*, *C. ferruginea*, *C. fimbriata*, *C. firma*, *C. kitaibeliana*, *C. laevis*, *C. macrolepis*, *C. mucronata*, *C. sempervirens* ***A. sempervirentis***
- 1* Spores rounded to slightly irregular, wall evenly thickened 2
2. Spore wall with internal swellings 3
- 2* Spore wall without internal swellings 4
3. Spores 15–18 × 16–21 µm, internal swellings rather inconspicuous. On *C. misandra* ***A. altera***
- 3* Spores 14–19 × 11–17 µm, internal swellings observed in some spores. On *C. digyna*, *C. nakaoana* ***A. nepalensis***
4. Spores 14–21 × 18–25 µm. On *C. atrofusca*, *C. ferruginea*, *C. fuliginosa*, *C. ktausipali*, *C. misandra*, *C. pachyrrhiza*, *C. petricosa* ***A. misandrae***
- 4* Spores 15–17 × 14–17 µm. On *C. stenocarpa* ***A. stenocarpae***

Acknowledgements

I am grateful to Dr. Kálmán Vánky (Tübingen, Germany) and Assistant Professor Wiesław Mułenko (Lublin, Poland) for reading the manuscript, many helpful improvements and serving as pre-submission reviewers, to Dr. Jolanta Cabała (Kraków, Poland) for her skilful drawings, to Dr. Krzysztof Pawłowski (Kraków, Poland) for providing the Latin description, and to Anna Łatkiewicz (Kraków, Poland) for help with Scanning Electron Microscope. SEM micrographs were taken in the Laboratory of Field Emission, Scanning Electron Microscopy and Microanalysis at the Institute of Geological Sciences of the Jagiellonian University, Kraków. This study was supported in part by the State Committee for Scientific Research in Poland (KBN), grants no. 2 P04G 019 28 and 2P04G 076 26p02, and by W. Szafer Foundation of Polish Botany.

Literature Cited

- Aarnæs JO. 2002. Catalogue over macro- and micromycetes recorded for Norway and Svalbard. Synopsis Fungorum 16: 1-412.
- Bauer R, Oberwinkler F, Vánky K. 1997. Ultrastructural markers and systematics in smut fungi and allied taxa. Canad. J. Bot. 75: 1237-1314.
- Bauer R, Begerow D, Oberwinkler F, Piepenbring M, Berbee ML. 2001. Ustilaginomycetes. In: DJ. McLaughlin, EG. McLaughlin & PA. Lemke (eds), The Mycota. 7. Systematics and Evolution Part B, pp. 57-83. Springer Verlag, Berlin-Heidelberg.
- Braun U. 1999. An annotated list of Mongolian phytoparasitic micromycetes. Schlechtendalia 3: 1-32.
- Chlebicki A. 2002. Two cypericolous smut fungi (Ustilaginomycetes) from the Thian Shan and their biogeographic implications. Mycotaxon 83: 279-286.
- Ellis JB, Tracy SM. 1890. A few new fungi. J. Mycol. 6: 76-77.
- Ershad D. 2000. *Vankya*, a new genus of smut fungi. Rostaniha 1: 65-72 (in English) & 151-161 (in Farsi).
- Kakishima M, Ono Y. 1988. Three species of smut fungi (*Ustilaginales*) from Nepal. In: M. Watanabe & SB. Malla (eds), Cryptogams of the Himalayas. Vol. I. The Kathmandu Valley, pp. 127-132. Department of Botany, National Science Museum, Tsukuba, Japan.
- Kawecka-Starmachowa B. 1936(1935). Die Brandpilze Polens. 1. Teil. *Ustilagineae*. Spraw. Komis. Fizjogr. 68/69: 117-76 (in Polish with German summary).
- Kochman J. 1936. Grzyby główniowe Polski. Planta Polonica 4: 1-161 + tabs i-xii (in Polish).
- Kochman J, Majewski T. 1973. Basidiomycetes, *Ustilaginales*. In: J. Kochman & A. Skirgiełło (eds), Flora Polska. Rośliny zarodnikowe Polski i ziem ościennych. Grzyby. 5. Państwowe Wydawnictwo Naukowe, Warszawa-Kraków (in Polish).
- Kukkonen I. 1963. Taxonomic studies on the genus *Anthracoidea* (Ustilaginales). Ann. Bot. Soc. Zool. Bot. Fennicae 'Vanamo' 34(3): 1-22.
- Lizoň P, Bacigálová K. 1998. Fungi. In: K. Marhold & F. Hindák (eds), Checklist of non-vascular and vascular plants of Slovakia, pp. 101-227. VEDA vydavateľstvo Slovenskej akadémie vied, Bratislava.
- Minter DW, Dudka IO. 1996. Fungi of Ukraine. A preliminary checklist. CAB International, Wallingford.
- Nannfeldt JA. 1979. *Anthracoidea* (Ustilaginales) on Nordic *Cyperaceae*-*Caricoideae*, a concluding synopsis. Symb. Bot. Upsal. 22(3): 1-41.
- Paulech P. 1998. The genus *Anthracoidea* (Ustilaginales) in Slovakia. Bull. Slov. Bot. Spoločn., Bratislava 20: 20-26 (in Slovak with English abstract).
- Paulech P, Zlinská J, Szittayová S. 1997. *Anthracoidea michelii* and *Thecaphora affinis* in Slovakia. Czech Mycol. 50(2): 119-125.
- Piątek M, Ruskiewicz-Michalska M, Mułenko W. Catalogue of Polish smut fungi, with notes on four species of *Anthracoidea*. Polish Bot. J. (submitted).
- Romaszewska-Safata J. 1982. Species of microscopic phytopathogenic fungi new and rare in Polish flora. Ann. Univ. Maria Curie-Skłodowska, Sec. C 37: 201-214 (in Polish with Russian and English summaries).
- Uljanishchev VI. 1968. Opređeliteľ goľovnevyykh gribov SSSR. Nauka, Leningrad.
- Vánky K. 1979. Species concept in *Anthracoidea* (Ustilaginales) and some new species. Bot. Not. 132: 221-231.
- Vánky K. 1985. Carpathian *Ustilaginales*. Symb. Bot. Upsal. 44(2): 1-309.
- Vánky K. 1994. European smut fungi. G. Fischer Verlag, Stuttgart-Jena-New York.

- Ványk K. 1998a. The genus *Microbotryum* (smut fungi). Mycotaxon 67: 33-60.
- Ványk K. 1998b. Taxonomical studies on *Ustilaginales*. XVIII. Mycotaxon 69: 93-115.
- Ványk K. 1999. The new classificatory system for smut fungi, and two new genera. Mycotaxon 70: 35-49.
- Ványk K. 2002. Taxonomical studies on *Ustilaginales*. XXII. Mycotaxon 81: 367-430.
- Ványk K. 2004. Taxonomic studies on Ustilaginomycetes – 24. Mycotaxon 89(1): 55-118.
- Ványk K, Bauer R, Begerow D. 1997. *Fulvisporium*, a new genus of *Ustilaginales*. Mycotaxon 64: 57-66.
- Zwetko P. 2003. Zur Kenntnis der Rost- und Brandpilze Österreichs. Fritschiana 42: 77-82.

***Parapyricularia brasiliensis*, a new dematiaceous hyphomycete on *Gmelina arborea* from Brazil**

ADRIANO MÁRCIO FREIRE SILVA

MARIA ANGÉLICA GUIMARÃES BARBOSA

MARIA MENEZES

MARCOS P. S. CÂMARA

adrianomfsilva@bol.com.br angelguim@hotmail.com

mmenezes@hotlink.com.br mcamara@ufrpe.br

Área de Fitossanidade, Universidade Federal Rural de Pernambuco
Rua Dom Manoel de Medeiros, Dois Irmãos, Recife-Pernambuco, 52171-900, Brazil

Abstract—The new species *Parapyricularia brasiliensis* was observed on leaf spot of *Gmelina arborea* in Brazil. *G. arborea* is a plant species of Asian origin that was introduced into Brazil. *P. brasiliensis* differs from the previously described species of the genus based mainly on the number of branches of the conidiophore (two to four), length of conidiophore stipe, a protuberant conidial hilum, and conidial length and septation.

Key words—systematics, tropical fungi

Introduction

A hyphomycete was observed on a leaf spot of *Gmelina arborea* Roxb. (Verbenaceae). *Gmelina arborea* has its center of origin in tropical and sub-tropical areas of Asia. Due to its rapid growth rate, this plant species is often used in reforestation programs in many tropical areas as a source of timber and cellulose (Agrosoft 2000). *Gmelina arborea* was introduced into Brazil from Asia in the 1960s during a reforestation project located in the Amazon basin. This fungus was collected during the rainy season of 2003 in the city Recife on the Atlantic coast of the Brazilian state of Pernambuco (08°01'S, 34°56'W). The region is characterized by a tropical climate with an average rainfall of 1500 mm/year and average annual temperature of 26°C (Vianello & Alves 1991). The fungus was collected on hypophyllous leaf spots that were mostly irregular, dark brown, not limited by the leaf veins, and occurring mainly on older leaves.

Materials and Methods

The fungal material examined originated from leaves of two trees that were close to each other. Micromorphological observations were made from material mounted in Shear's

mounting fluid or lacto-glycerol-cotton blue. Morphological data were based on at least 50 measurements of each fungal structure used for taxonomic diagnoses. Histological sections were prepared in order to observe the relationship between the fungus and the host tissue. Images were captured using a Olympus PM – AK 10 camera mounted on a Olympus BX41 microscope. Specimens were deposited in the Mycological Reference Collection of the Herbarium Camille Torrand Collection (URM), Recife, Brazil of the Universidade Federal de Pernambuco.

Taxonomic Description

Parapyricularia brasiliensis A. Silva, M.A.G. Barbosa, M. Menezes, M.P.S. Câmara sp. nov. FIGURES 1-5

Maculae amphigenae, coloniae hypophyllae olivaceo-brunnea; mycelium partim superficiales, hyphis ramosis, septatis, laevibus, hyalinis; conidiophori cylindrici, erecti, singulares omnes stipitem et capitulum compositum; cellulis basalibus plus minus inflatis et cellulae conidiogeniae in conidiophoris incorporatae, terminales, sympodiales, denticulatae; conidia singularia in denticulis, obclavata vel obclavato-cylindrica, recta vel subarcuata, pallide olivacea-brunnea, septis 1-8 transversis, 19.5–66 µm longae, 4.5–6 µm latae, hilum parum, distincte incrassato 1 x 1–1.5 µm.

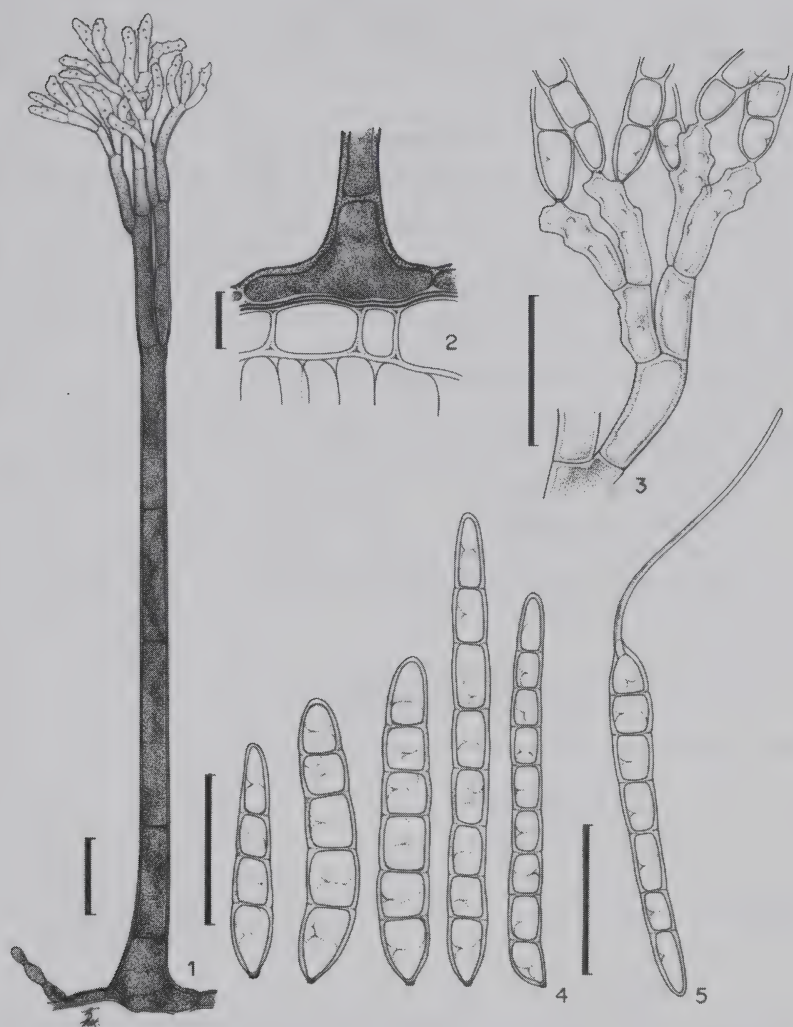
Holotypus hic designatus: In foliis vivis Gmelina arborea. In Universidade Federal Rural de Pernambuco-UFRPE, Recife-PE (URM) deposita.

Etymology: brasiliensis refers to Brazil, the country where the fungus was found.

EXPANDED DESCRIPTION — **Leaf spots** dark brown, amphigenous, mostly irregular, and not limited by the leaf veins. **Mycelium** superficial, branched, septate, smooth, hyaline; **Conidiophores** solitary, macronematous, erect, composed of a much-branched fertile head and a sterile stipe, 247–55 µm long. Stipe 179–418 µm long, straight, smooth, cylindrical, unbranched, septate, thick-walled, dark brown below becoming lighter toward the apex, 7–13 µm wide at base, cells at base not swollen; terminating in the fertile head. Fertile head terverticillate, compact; 1° and 2° branches cylindrical, straight (11.5–72 × 4.0–7 µm) brown to pale brown. 3° and 4° branches cylindrical, straight, short, (12–23.5 × 4.5–7.5 µm), pale brown. **Conidiogenous cells** arising from 3° and 4° branches singly or in appressed whorls of 2 or 3, cylindrical, polyblastic, denticulate; denticles cylindrical, (1×1–1.5µm), truncate. **Conidia** acropleurogenous, solitary, obclavate, straight or slightly curved, smooth, thick-walled, hilum protuberant, pale brown, with 1–8 transverse septa (19.5–66 × 4.5–6 µm), germination polar.

REPRESENTATIVE SPECIMENS EXAMINED — BRASIL. PERNAMBUCO: Universidade Federal Rural de Pernambuco, Recife (08°01' S, 34°56' W) (HOLOTYPE-URM 78637) — 20.IV.2003 A.M.F. Silva on leaves of *G. arborea* Roxb.

COMMENTS — The fungus is characteristic of *Parapyricularia* M.B. Ellis, a genus of dematiaceous hyphomycetes. *Parapyricularia* is characterized by macronematous, mononematous conidiophores composed of a sterile stipe and a complex head of branches, each of which terminates in one or more polyblastic, denticulate conidiogenous cells. Conidia are acropleurogenous, solitary, simple, straight or curved, 1–3 (usually 2) septate, pale brown, rarely brown, smooth, and have a protuberant hilum (Ellis &



FIGS. 1–5. *Parapyricularia brasiliensis* 1. Conidiophore showing stipe and terverticillate head 2. Transverse section of the leaf of *Gmelina arborea* showing the superficial conidiophore of *P. brasiliensis* 3. Conidiogenous cells with conidia attached to denticles 4. Conidia 5. Polar conidial germination. Scale bars: 1, 2 = 25 μm ; 3–5 = 15 μm .

Peregrine 1972). Two species of *Parapyricularia* have been described, both from Asia. *Parapyricularia musae* was originally described from *Musa* sp. (Ellis & Peregrine 1972) and *P. gymnematis* from *Gymnema tingens* Roxburgh ex Sprenger (Rai & Kamal 1985). The Brazilian species differs significantly from the previously described species

of the genus and is proposed as new. Conidiophores of *P. brasiliensis* are typical of the genus in possessing a distinct sterile stipe and a compact, fertile head and denticulate conidigenous cells. *Parapyricularia* resembles *Pyricularia* but conidiophores of that genus are not branched (Ellis 1976). The fertile head of *Parapyricularia* also suggests *Periconiella*, but conidigenous cells in that genus bear cicatrized scar (Ellis 1976).

Parapyricularia brasiliensis can be distinguished from the other described species in this genus by a number of characters (Table 1). It differs from *P. gymnematis* in that *P. brasiliensis* has some superficial mycelium, non-fasciculate conidiophores with no swollen basal cell, and longer and wider stipes than *P. gymnematis*. Additionally, the conidiophore heads of *P. brasiliensis* are more highly branched and conidia are shorter than those of *P. gymnematis*, and conidia of *P. brasiliensis* have a rounded base, thick wall, 1–8 septa, and a protuberant hilum. *Parapyricularia brasiliensis* can be distinguished from *P. musae* by the shorter and thicker stipe, smaller size of the primary branches and a more highly branched head in the former. In addition, the conidia of *P. brasiliensis* are longer and narrower and have more transverse septa than those *P. musae*. Conidia of both, *P. brasiliensis* and *P. musae* have a protuberant hilum.

A search of the extensive host/fungus list in Farr et al. (2004), which includes Teng's Fungi of China (1996), reveals species in 34 fungal genera have been found on *G. arborea* but none of the hyphomycetes suggests the genus *Parapyricularia*. Because the two known species of *Parapyricularia* were described in Asia and the host plant of *P. brasiliensis* was introduced into Brazil from that continent in the 1960's we can only speculate that the species described here was introduced in Brazil together with its host.

The disease symptoms associated with the presence of the fungus are very minor and no attempt to fulfill the Koch's postulate was made.

Table 1. Morphological characteristics of *Parapyricularia* species.

Species	Conidiophores (μm)	Conidia		
		Size (μm)	Septa	Shape
<i>P. brasiliensis</i>	Stipe 179–418 $\times$ 7.0–13, primary branches 18.5–72 $\times$ 4.0–6.5	19.5–66 $\times$ 4.5–6	1–8, transverse	Obclavate, hilum protuberant and dark
<i>P. gymnematis</i>	Stipe 64.5–195.5 $\times$ 5.7–6.8, primary branches 16–85 $\times$ 4.6–6.8	27.5–82.8 $\times$ 4–6.3	1–6, transverse	Obclavate to obclavato-cylindric, hilum not protuberant but slightly thickened and dark
<i>P. musae</i>	Stipe up to 1000 $\times$ 5–9, primary branches up to 120 $\times$ 4–6	27–33 $\times$ 7–10	1–3, transverse	Obturbinate to obclavate, hilum protuberant

Acknowledgments

We thank Dr. Mary Palm-Hernandez, Dr. Gary Samuels, and Dr. Elwin Stewart for the critical review of the manuscript.

Literature Cited

- Agrosoft. 2000. Serie-Especies Forestales: *Gmelina arborea* Roxb. <<http://www.colforest.com.co>>. Medellin.
- Ellis MB, Pegregrine. 1972. Dematiaceous hyphomycetes XI. Mycol Papers 131: 187–189.
- Ellis MB. 1976. More dematiaceous hyphomycetes. Kew, Commonwealth Mycological Institute.
- Farr DF, Rossman AY, Palm ME, McCray, EB. 2004. Fungal Databases. <<http://nt.ars-grin.gov/fungaldatabases/>>. Systematic Botany & Mycology Laboratory, ARS, USDA, Beltsville, MD.
- Rai B, Kamal. 1985. A new species of *Parapyricularia* from India. Can J Bot 63: 988–989.
- Teng SC. 1996. Fungi of China. Edited by RP Korf; Mycotaxon, Ltd, New York. 586 p.
- Vianello RL, Alves AR. 1991. Meteorologia básica e aplicações. Viçosa: Imprensa Universitária. 449 p.

***Ramularia pistiae* sp. nov. — a new leaf spot fungus on water lettuce (*Pistia stratiotes*) from Nicaragua**

R. C. FERNANDES & R. W. BARRETO

rbarreto@ufv.br

*Departamento de Fitopatologia, Universidade Federal de Viçosa
Viçosa, 36571-000, MG, Brazil*

Abstract — A new species of *Ramularia*, associated with leaf spots on the pantropical aquatic weed *Pistia stratiotes* (water lettuce) inhabiting roadside ponds in Nicaragua, is described. The fungus is compared with *Ramularia aromatica*, the sole other species in this genus known to attack a member of the *Araceae*. *P. stratiotes* is one of the world's worst aquatic weeds and has been the target of several biological control programs. The new fungus is named *Ramularia pistiae* and represents the second fungal pathogen to be reported on this host in the Neotropics, which is considered to be the center of origin of this weed. A thorough search in different parts of Brazil for fungi to be used as biological control agents only yielded a single fungus (*Cercospora pistiae*) which is already known to occur in the Old World. This record indicates that in the future, surveys for natural enemies of *P. stratiotes* should include Central America.

Key Words — hyphomycetes, *Moniliaceae*, cercosporoid, classical biocontrol

Introduction

Pistia stratiotes L. (water lettuce) is an aquatic plant belonging to the *Araceae* that produces attractive floating rosettes of spongy leaves. It is one of the most wide spread of all aquatic plants and has been recorded in most tropical regions of the world except for some oceanic islands (Kissman 1997). It is an aggressive invader of slow moving waters in the tropics and causes serious impacts on all forms of freshwater utilization. Indirectly, it also negatively impacts on human health, since it can favor the breeding of several species of mosquitoes that vector diseases (Holm 1977). Bennet (1975) ranked it third among the worst world's aquatic weeds. Its pantropical distribution appears to have occurred in ancient times, but its origin is still a matter of debate. However, the successful introduction of a host specific insect (*Neohydronomus affinis* Hustache) originating from Brazil, into Australia (Harley et al. 1984) and later into Papua New Guinea (Laup 1987) and South Africa (Cilliers et al. 1987, 1996) to serve as natural enemy seems to support a Neotropical origin.

Intensive field examinations in the Brazilian states of Rio de Janeiro, Espírito Santo, Minas Gerais, Bahia, Sergipe and Alagoas, were carried out to find fungal pathogens for potential use as biocontrol agents against various native pantropical aquatic weeds (Barreto and Evans 1996; Barreto et al. 1999, 2000; Hanada 1998). Only a single pathogen, *Cercospora pistiae* Nag Raj, was found attacking *P. stratiotes*, and this

species is already known to occur in South Africa and India. The new record of this fungus from Brazil and its implications as a potential biocontrol agent were discussed by Barreto et al. (1999). In 2003, an ad hoc collection made during a trip to Nicaragua revealed an addition to the mycobiota of *P. stratiotes*, which is described below.

Material and Methods

Samples of infected leaves were dried in a plant press and later deposited in the herbarium at the Federal University of Viçosa (VIC). Although the fungus was successfully isolated in pure cultures by directly isolating onto V8-juice-agar, these cultures did not survive preservation in silica-gel and were lost. Morphology of the fungus was studied and illustrated with an Olympus BX 50 light microscope fitted with a drawing tube.

Taxonomic Description

Ramularia pistiae sp. nov. R. C. Fernandes & R. W. Barreto

FIGURE 1

Maculae subcirculares-ellipticae, centro brunneae, margine albidae, 8-45 x 6-20 mm. Mycelium immersum, ramosum, septatum, hyalinus. Mycelium externum amphigenus, ramosum, septatum, hyalinus, laevis. Stromata nulla. Conidiophora amphigenae, fasciculata, cylindrica, recta vel flexuosa, 20.0-74.0 x 2.0-3.0 µm, 0-2 septata, interdum ramosa, hyalina, levia. Cicatrices conidiales leniter incrassatae, fuscae, 1 µm diam. Conidia sicca, catenata, interdum ramicatenata, holoblastica, subcylindrica-fusiformia, 3.0-24.5 x 1.0-3.0 µm, 0-1 septata, hyalina, levia, apice rotundato vel obconico, basi obconica, hila leniter incrassata, fusca, 1 µm diam.

Etymology: based on the name of the host genus.

Lesions on living leaves, subcircular to elliptical with a brown center of depressed (collapsed) host tissue surrounded by a periphery of yellowed tissue covered by a white powdery mass of fungal material, increasing in size and leading to foliar perforations 8-45 x 6-20 mm; **internal mycelium** septate, branched, hyaline, almost indistinct; **external mycelium** amphigenous, branched, septate, hyaline, smooth; **stromata**, absent; **caespituli** amphigenous. **Conidiophores** fasciculate, cylindrical, straight to slightly curved or sinuous, 20.0-74.0 x 2.0-3.0 µm, 0-2-septate, occasionally branched, hyaline, smooth; **conidiogenous cells** terminal, simpodial, sub-cylindrical, straight to somewhat sinuose, often tapering towards the apices, 11.5-26.5 x 1.5-2.5 µm, hyaline, smooth; **conidiogenous loci**, 1-3 per conidiogenous cell, slightly thickened, darkened, 1 µm wide. **Conidia** dry, forming long acropetal, occasionally branched chains, holoblastic, subcylindrical-fusiform, 3.0-24.5 x 1.0-3.0 µm, 0-1-septate, hyaline, smooth, thin-walled, distinctly guttulate (each conidial cell filled with one large vacuole), apex rounded or obconical, base obconical, hila darkened and slightly thickened, 1 µm wide.

Ecology, Range and Distribution – Known only from *P. stratiotes* at the type locality.

SPECIMEN EXAMINED – NICARAGUA: roadside ponds between TIPITAPA and SAN BENITO, on living leaves of *Pistia stratiotes*, R.W. Barreto and H.C. Evans, 30.VI.2002, (HOLOTYPE- VIC 27826).

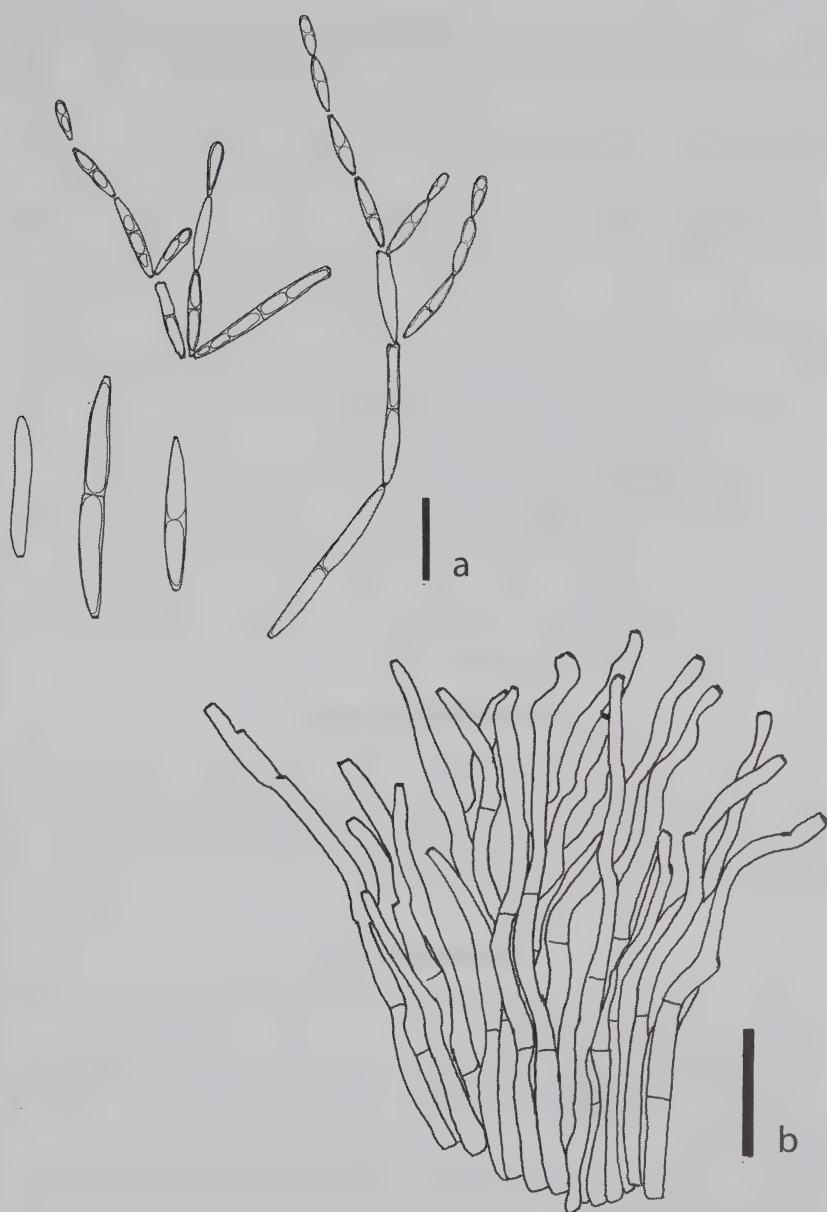


Fig. 1. *Ramularia pistiae*: a) conidia and conidial chains; b) conidiophore fascicle. Bar = 10 μm .

COMMENTS — The fungus on *P. stratiotes* clearly belongs to the genus *Ramularia*. This genus has recently been monographed by Braun (1998). Only one species of *Ramularia* has been described on a member of the *Araceae*: *Ramularia aromatica* (Sacc.) Höhn. on *Acorus calamus* L. in Europe, Asia and North America (Braun 1998). Although this species is somewhat similar to *R. pistiae*, there are some morphological differences separating them. Conidiophores are thicker (up to 5 μm) and shorter (up to 40 μm) in *R. aromatica* as compared with a maximum of 3 μm wide and up to 74.5 μm long in *R. pistiae*. Conidia are also longer and thicker in *R. aromatica* (6-55 x 1-5 μm) and up to 4-septate whereas conidia in *R. pistiae* are only 0-1 septate. This represents therefore the second member of *Ramularia* to be described on a plant belonging to the *Araceae*.

The newly described fungus appears to be only the second fungal pathogen to be found in nature on this host in the Neotropics. The known mycobiota of *P. stratiotes* is notably scanty, being limited to only eight fungi, most of which are known to be polyphagous. With the exception of *Cercospora pistiae* and an undetermined *Cercospora* sp. (possibly an incomplete record of *C. pistiae*) other records are from the Old World, where *P. stratiotes* is believed to be exotic (Barreto et al 1999). *Ramularia pistiae* belongs to a group of fungi that are in general considered to be specialized parasites.

The damage inflicted by *R. pistiae*, that was observed in the field, was not severe, indicating that this pathogen may not have promise as a biocontrol agent. The fungus affected mostly older leaves on an otherwise healthy looking and very dense population of plants. However, the agent should not be rejected prematurely, since the fungus may cause significant damage during other seasons, and could be utilised using an augmentative biocontrol strategy. This new record clearly indicates that future searches for natural enemies of *P. stratiotes* should include Central America.

Acknowledgements

R.W. Barreto wishes to acknowledge financial support from CNPq (Conselho Nacional do Desenvolvimento Científico e Tecnológico) and to thank J. Medal, organizer of the Primer Curso Latinoamericano de Control Biológico de Malezas (June 2002, Montelimar, Nicaragua) for providing the necessary funds for the trip to Nicaragua, the authors also wish to acknowledge the significant contributions made by Professor Uwe Braun and Dr. Carol Ellison the reviewers of the present article.

Literature Cited

- Barreto RW, Charudattan R, Pomella A, Hanada R. 2000. Biological control of neotropical aquatic weeds with fungi. *Crop Protection* 19: 697-703.
- Barreto RW, Evans HC. 1996. Fungal pathogens of some Brazilian aquatic weeds and their potential use in biocontrol. In: Moran VC, Hoffmann JH, Eds. *Proceedings of the IX International Symposium on Biological Control of Weeds*: 121-126. Stellenbosch, South Africa: University of Cape Town.
- Barreto RW, Evans HC, Hanada RE. 1999. First record of *Cercospora pistiae* causing leaf spot of water lettuce (*Pistia stratiotes*) in Brazil, with particular reference to weed biocontrol. *Mycopathologia* 144: 81-85.
- Bennett F. 1975. Insects and plant pathogens for the control of *Salvinia* and *Pistia*. In: Brezonik PL, Fox JL, Eds. *Proceedings of a Symposium on Water Quality Management through Biological Control*: 28-34. Gainesville, USA: University of Florida.

- Braun, U. 1998. A monograph of *Cercospora*, *Ramularia* and allied genera (phytopathogenic hyphomycetes). Vol 2. München: IHW- Verlag.
- Cilliers C. 1987. First attempt at and early results on the biological control of *Pistia stratiotes* L. in South Africa. Koedoe 30: 35-40.
- Cilliers C, Zeller D, Strydom G. 1996. Short- and long-term control of water lettuce (*Pistia stratiotes*) on seasonal water bodies and on a river system in the Kruger National Park, South Africa. Hydrobiologia 340: 173-179.
- Hanada RE. 1998. Fungos Fitopatogênicos para o Controle Biológico de Plantas Aquáticas Invasoras. [M.Sc. dissertation]. Viçosa (Brazil) Universidade Federal de Viçosa (Brazil) ,
- Harley KLS, Forno IW, Kassulke RC, Sands DPA. 1984. Biological control of water lettuce. Journal of Aquatic Plant Management 22: 101-102.
- Holm LG, Plucknett DL, Pancho JV, Herberger, JP. 1977. The World's Worst Weeds. Distribution and Biology. Honolulu, U.S. A.: University Press of Hawaii.
- Kissman KG. Plantas Infestantes e Nocivas. 1997. São Paulo, Brazil: BASF Brasileira S.A.
- Laup S. 1987. Biological control of water lettuce: early observations. Harvest 12: 41-43.

Taxonomic revision of the genus *Cladosporium* s. lat. 3. A revision of *Cladosporium* species described by J.J. Davis and H.C. Greene (WIS)

KONSTANZE SCHUBERT

konstanze.schubert@botanik.uni-halle.de

*Martin-Luther-Universität, FB. Biologie, Institut für Geobotanik und Botanischer
Garten, Neuwerk 21, D-06099 Halle (Saale), Germany*

Abstract—Type specimens and other collections of *Cladosporium* species described by J.J. Davis and H.C. Greene have been re-examined. They are described, illustrated, discussed and taxonomically re-assessed. The new combinations *Fusicladium artemisiae*, *F. astericola*, *F. baptisiae*, *F. caducum*, *F. coreopsidis*, *F. monardae* and *Stenella stipae* are introduced. A key to the *Fusicladium* species on *Asteraceae* is provided. *Cladosporium americanum* is reduced to synonymy with *Fusicladium carpophilum* and *C. brachyelytri* proven to be a synonym of *Passalora fusimaculans* var. *barretoana*. *C. trichophilum* described on *Lonicera hirsuta* is conspecific with *Passalora nopomingensis*.

Key words—hyphomycetes, taxonomy

Introduction

Types and other collections of *Cladosporium* Link species described by the American mycologists J.J. Davis and H.C. Greene and housed at WIS (abbreviation according to Holmgren et al. 1990) have been re-examined. Three of them have already been re-assessed (Heuchert et al. 2005; Schubert & Braun 2005; Schubert et al. 2003). The other species have conidiogenous loci and conidial hila that exclude them from *Cladosporium* emend. (David 1997; Braun et al. 2003) and most of them have to be assigned to *Fusicladium* Bonord. emend. (Schubert et al. 2003). Davis and Greene undoubtedly followed a wide generic concept in which fusicladium-like species with catenate conidia had been assigned to *Cladosporium* s. lat. (e.g., Bensaude & Keitt 1928). Monographic studies (Schubert et al. 2003), molecular examinations within the genus *Fusicladium* (Beck et al. 2005) and morphological studies of other genera, e.g., *Ramularia* Unger (Braun 1998) have shown that conidial formation (solitary or in chains) is a taxonomic character that should not be used at the generic level. This paper is an additional contribution to a morphotaxonomic revision of the genus *Cladosporium* s. lat. Detailed descriptions, illustrations and comments upon the species treated herein are given.

Material and Methods

All collections have been examined and measured, mounted in distilled water, by standard light microscopy (Olympus BX 50, Hamburg, Germany). Stains were not used

as the fungal hyphae are pigmented and thus clearly visible. Slides were examined using bright field and phase contrast. Measurements have been based on 20 conidiophores, conidia, etc., respectively. Drawings were done free hand.

Re-assessment of *Cladosporium* species described by J.J. Davis and H.C. Greene

1. *Cladosporium americanum* H.C. Greene

Fig. 1

Fusicladium carpophilum (Thüm.) Oudem., Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. 1900: 388 (1900).

= *Cladosporium americanum* H.C. Greene, Amer. Midl. Naturalist 41(3): 723 (1949), **syn. nov.**

On living leaves, without distinct spots and discolorations. Colonies hypophyllous, on leaf blades and veins, loosely scattered, brown to dark brown. Mycelium internal, subcuticular, hyphae branched, 1.5–3 μm wide, septate, slightly constricted at the septa, sometimes with small swellings, pale brown to pale medium brown, smooth, walls unthickened to slightly thickened. Stromata absent. Conidiophores solitary, arising from internal mycelium, erumpent through the cuticle, erect, straight to slightly flexuous, often somewhat geniculate-sinuuous, unbranched or occasionally branched, 25–83 $\times$ (3–)3.5–6(–7) μm , septate, sometimes slightly constricted at the septa, medium to dark brown, smooth, walls thickened, not or slightly swollen at the base, sporadically enteroblastically proliferating (percurrent proliferations which are not connected with conidiogenesis). Conidiogenous cells integrated, terminal and intercalary, oblong-cylindrical to somewhat irregular, 9–38 μm long, proliferation sympodial, cicatrized, with numerous subdenticulate conidiogenous loci, truncate to slightly convex, 1–1.5(–2) μm wide, unthickened, somewhat darkened-refractive. Conidia solitary or in unbranched, very rarely in branched chains, straight, fusiform, ellipsoid to subcylindrical, (6–)11–18(–22) $\times$ 4–6(–7) μm , 0(–1)-septate, not or slightly constricted at the septum, pale olivaceous to olivaceous, smooth to occasionally faintly asperulate, walls not to slightly thickened, apex rounded to pointed, hila truncate to slightly convex, 1–1.5(–2) μm wide, unthickened, somewhat darkened-refractive.

MATERIAL EXAMINED: on *Prunus americana* (Rosaceae), USA, Wisconsin, Dane Co., Madison, 2 Aug. 1952, H.C. Greene (WIS); Univ. Wisconsin Arboretum, 18 Sept. 1944, H.C. Greene (WIS, syntype); Hillside, 82-14, 27 Aug. 1945, H.C. Greene (WIS); Pine plantation, 82-11, 27 Aug. 1945, H.C. Greene (WIS); 64-16, 27 Aug. 1945, H.C. Greene (WIS).

The supposition of a close affinity or even identity of *Cladosporium americanum* with *C. cladosporioides* (Fresen.) G.A. de Vries by Braun (2001) and Dugan et al. (2004) could not be confirmed by the examination of type material. *C. americanum*, characterized by having approximately 50 % or more conidia formed in chains, is conspecific with the cosmopolitan *Fusicladium carpophilum*. The latter species occurs on many different hosts of the genus *Prunus* s. lat. including *P. americana*. The allied species *F. cerasi* (Rabenh.) Erikss., which is restricted to *Prunus cerasus* (= *Cerasus*

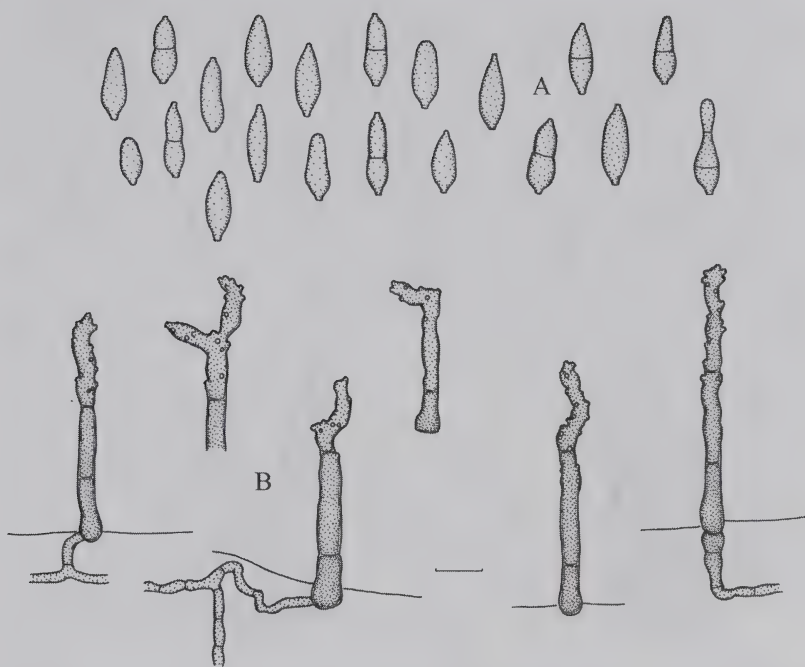


Fig. 1. *Fusicladium carpophilum*. Conidiophores and conidia from type material of *C. americanum*. A – conidia, B – conidiophores. Bar = 10 μ m.

vulgaris) and a few allied hosts, is morphologically (conidia usually formed solitary and only very rarely in unbranched chains), physiologically (differences in temperature tolerance) and genetically (Beck et al. 2005) distinct from *F. carpophilum*. Bensaude & Keitt (1928), who carried out comparative studies of certain ‘*Cladosporium*’ diseases of stone fruits, included samples of a ‘*Cladosporium*’ species on fruits, twigs and leaves of *Prunus americana* from Madison, Wisconsin, the same area from which *C. americanum* was later described. This fungus induced infection on leaves of *P. americana* and *P. persica* (= *Amygdalus persica*) and leaves and twigs of *P. armeniaca* (= *Armeniaca vulgaris*), but failed to infect *P. cerasus* and *P. domestica*. On the basis of the described morphology and the inoculation experiments carried out by Bensaude & Keitt (1928), *C. americanum* has to be reduced to synonymy with *F. carpophilum*.

2. *Cladosporium artemisiae* H.C. Greene

Fusicladium artemisiae (H.C. Greene) K. Schub. & U. Braun, **comb. nov.**

≡ *Cladosporium artemisiae* H.C. Greene, Amer. Midl. Naturalist 48(3): 757 (1952).

On living leaves, inconspicuous, without spots and discolorations. Colonies epiphyllous, rarely hypophyllous, in small tufts, loosely scattered, dark brown to blackish. Mycelium

Fig. 2

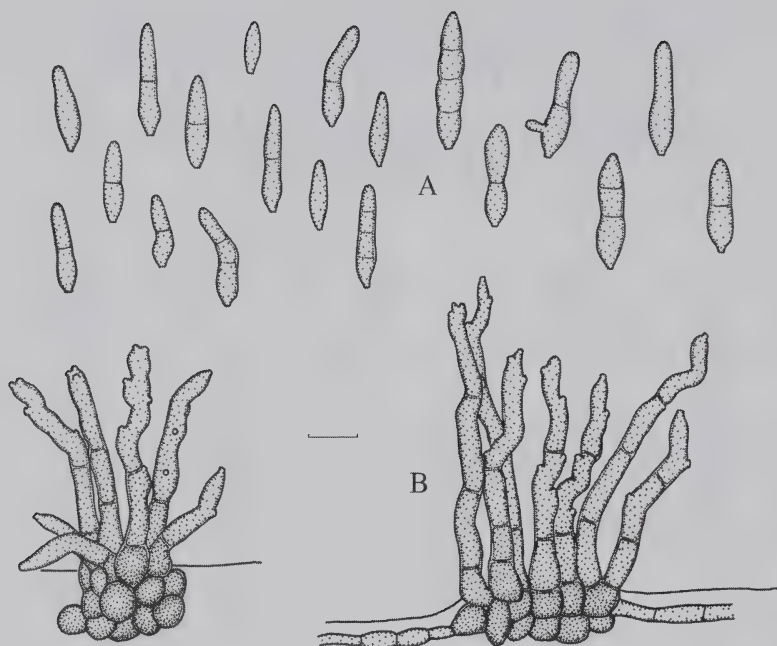


Fig. 2. *Fusicladium artemisiae*. Conidiophores and conidia from the type material. A – conidia, B – fascicles of conidiophores. Bar = 10 μm .

internal, subcuticular to intraepidermal, hyphae sparingly branched, 1.5–4 μm wide, septate, without swellings and constrictions, subhyaline to pale olivaceous brown, smooth, walls not or slightly thickened, with somewhat radiating, interconnected stromata. Stromata at first small, subglobose to oval, 15–30 μm diam., becoming more extended, oblong and somewhat flattened, up to 60(–90) μm diam., only few layers deep, composed of subglobose, oblong to somewhat angular swollen cells, 4–8 μm diam., pale to medium olivaceous brown or brown to even dark brown, smooth, walls only slightly thickened. Conidiophores fasciculate, arising from stromata, erumpent through the cuticle, erect to rarely somewhat subdecurrent, straight to slightly flexuous, often geniculate-sinuous, somewhat subnodulose, unbranched to occasionally branched, 15–65 $\times$ 3.5–5(–6) μm , 1–4-septate, not constricted at the septa, medium to dark brown or olivaceous brown, tips somewhat paler, smooth, walls only slightly thickened. Conidiogenous cells integrated, terminal to intercalary, 9–26 μm long, proliferation sympodial, with a single to few conidiogenous loci, subdenticulate, often on small lateral shoulders, truncate, 1–1.5(–2) μm wide, unthickened, somewhat darkened-refractive. Conidia solitary, straight to slightly curved, subcylindrical, subfusoid, 10–26(–29) $\times$ 3.5–5.5 μm , 0–1(–3)-septate, not or slightly constricted at the septa, pale olivaceous, smooth, walls slightly thickened, apex rounded, often slightly attenuated, hila truncate, 1–1.5(–2) μm wide, unthickened, not to slightly darkened-refractive.

MATERIAL EXAMINED: on *Artemisia caudata* (= *A. campestris* ssp. *caudata*) (*Asteraceae*), USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, sandy slope, 97-15, 7 Jul. 1951, H.C. Greene (WIS, syntype); 23 Jul. 1951, H.C. Greene (WIS, topotype).

Due to the typical denticle-like, truncate, unthickened conidiogenous loci, this species has to be assigned to *Fusicladium* emend. (Schubert et al. 2003). *Fusicladium virgaureae* Ondřej on *Solidago*, the second species occurring on a host of the family *Asteraceae*, is easily distinguishable in forming distinct leaf spots and shorter catenate conidia. Furthermore, the conidiophores arise solitarily from hyphae or in small tufts from aggregations of swollen hyphal cells. True stromata are absent (Ondřej 1971; Schubert et al. 2003). Morphologically similar species with usually fasciculate conidiophores differ in having catenate conidia [*F. scillae* (Deighton) U. Braun & K. Schub., *F. humile* (Davis) K. Schub. & U. Braun, *F. effusum* Winter], wider conidiophores [$4\text{--}8\text{ }\mu\text{m}$ wide in *F. caulicola* U. Braun & K. Schub., $4\text{--}11\text{ }\mu\text{m}$ wide in *F. pyrourum* (Lib.) Fuckel] and wider, denticulate conidiogenous loci and hila, respectively [$(1\text{--})1.5\text{--}2\text{--}(2.5)\text{ }\mu\text{m}$ in *F. crataegi* Aderh., $1.5\text{--}3\text{--}(4)\text{ }\mu\text{m}$ in *F. euphorbiae* Karak. and $1.5\text{--}2.5\text{ }\mu\text{m}$ in *F. faureyi* Deighton]. Zhang et al. (2003) reported *C. artemisiae* on *Artemisia subdigitata* from China, but their illustration deviates from the description and illustration of the type material in showing non-geniculate conidiophores with only terminal conidiogenous cells and shorter conidia formed in simple or branched chains. It remains unclear if this Chinese collection is conspecific with *C. artemisiae* or if it is maybe a true *Cladosporium*.

3. *Cladosporium astericola* Davis

Fig. 3

***Fusicladium astericola* (Davis) K. Schub. & U. Braun, comb. nov.**

≡ *Cladosporium astericola* Davis, Trans. Wisconsin Acad. Sci. 20: 428 (1922).

On upper leaves and upper portions of stems, forming pale yellowish brown or ochraceous discolorations, amphigenous, often along leaf veins, later becoming darker and forming small, somewhat subcircular to irregular spots, $1\text{--}5\text{ mm}$ wide, brown, sometimes surrounded by a paler brown halo, occasionally confluent. Colonies amphigenous, on discolorations and spots, scattered, loosely to densely caespitose, ochraceous to brown. Mycelium internal, subcuticular, to occasionally external, superficial, hyphae sparingly branched, $1.5\text{--}5\text{ }\mu\text{m}$ wide, septate, sometimes constricted at the septa, hyaline to subhyaline or pale brown, smooth, walls somewhat thickened, often somewhat swollen, swollen hyphal cells up to $7\text{--}(10)\text{ }\mu\text{m}$ wide, forming radiating hyphal plates. Stromata absent. Conidiophores solitary or loosely aggregated but not fasciculate, arising from swollen hyphal cells or hyphae, erumpent through the cuticle, erect to subdecumbent, straight to somewhat flexuous, slightly geniculate-sinuous, sometimes somewhat subnodulose, unbranched or occasionally branched, $17\text{--}100\text{--}(120) \times (3\text{--})4\text{--}6\text{--}(7)\text{ }\mu\text{m}$, septate, not or slightly constricted at the septa, pale brown, fuliginous, smooth, walls somewhat thickened, sporadically with a single percurrent proliferation, which is not connected with conidiogenesis. Conidiogenous cells integrated, terminal and intercalary, $8\text{--}35\text{ }\mu\text{m}$ long, proliferation sympodial, mostly distinctly denticulate, with several conspicuous conidiogenous loci, truncate, $1.5\text{--}3\text{ }\mu\text{m}$ wide, unthickened, refractive to

somewhat darkened. Conidia catenate, acro-pleurogenous, in unbranched or branched chains, straight, obovoid, fusiform, ellipsoid, subcylindrical, $(6-9-27 \times (3-4-6(-7) \mu\text{m}$, 0-1(-3)-septate, septum more or less median, not constricted or constricted at the septa, subhyaline to very pale yellowish brown or olivaceous-brown, smooth, walls not or only slightly thickened, apex rounded, usually slightly attenuated towards apex and base, hila truncate, basal hila $(1.5-2-3 \mu\text{m}$ wide, apical hila narrower, $(1-1.5-2 \mu\text{m}$ wide, unthickened, refractive to somewhat darkened, microcyclic conidiogenesis occurring, secondary conidia and conidiophores concolorous with conidiophores.

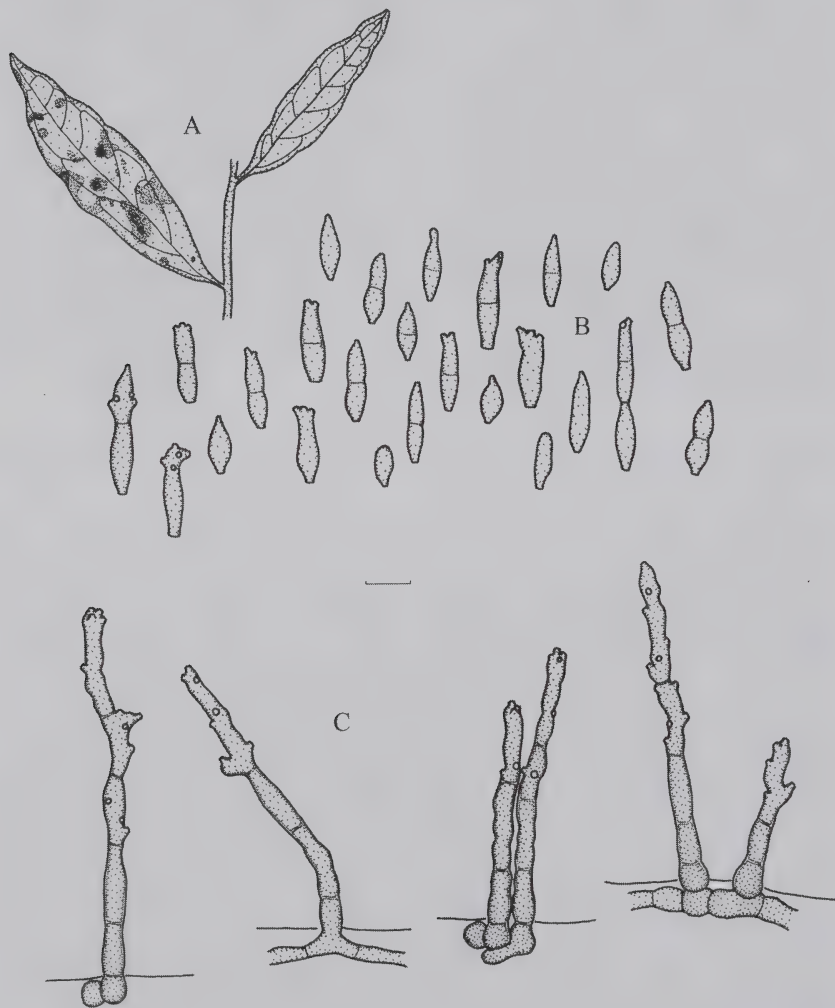


Fig. 3. *Fusicladium astericola*. Conidiophores and conidia from the type material. A - infected leaves (original size), B - conidia, C - conidiophores. Bar = $10 \mu\text{m}$.

MATERIAL EXAMINED: on *Aster azureus* (= *Symphyotrichum oolentangiense*) (*Asteraceae*, *Astereae*), USA, Wisconsin, Dane Co., near Sauk City, 5 Sept. 1952, H.C. Greene (WIS); *A. macrophyllus* (= *Eurybia macrophylla*), USA, Wisconsin, Sauk Co., 'Hemlock Draw' near Leland, 17 Aug. 1966, H.C. Greene (WIS); *A. oblongifolius* (= *Symphyotrichum oblongifolium*), USA, Wisconsin, Sauk Co., Ferry Bluff, 10 Aug. 1959, H.C. Greene (WIS); *A. oblongifolius* var. *angustatus* (= *Symphyotrichum oblongifolium*), USA, Wisconsin, Columbia Co., Black Hawk's Lookout, near Prairie du Sac, 15 Aug. 1945, H.C. Greene (WIS); *A. sagittifolius* (= *Symphyotrichum cordifolium*), USA, Iowa, Mondamin, 24 Aug. 1927, W.A. Archer, Mycol. Plant Disease Survey Iowa, No. 1287 (WIS); Wisconsin, Dane Co., near Cross Plains, 30 Jun. 1964, H.C. Greene (WIS); Madison, Univ. Wisconsin Arboretum, Prairie remnant, edge of woods, 58-4, 22 Aug. 1944, H.C. Greene (WIS); Green Co., New Glarus Woods, 5 Aug. 1948, H.C. Greene (WIS); *A. umbellatus* (= *Doellingeria umbellata* var. *umbellata*), USA, Wisconsin, Crandon, 29 Aug. 1921, J.J. Davis (WIS); Mellen, 4 Aug. 1919, J.J. Davis (WIS, syntype); Sawyer Co., Flambeau State Forest near Oxbow, 24 Jul. 1964, H.C. Greene (WIS); *Solidago altissima* (= *S. canadensis* var. *scabra*), USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, Prairie, 82-7, 26 Aug. 1944, H.C. Greene (WIS); *S. gigantea*, USA, Wisconsin, Lone Rock, 23 Jul. 1921, J.J. Davis (WIS); *S. graminifolia* (= *Euthamia graminifolia*), USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, Meadow, 65-7, 2 Aug. 1951, H.C. Greene (WIS); Green Co., near Monticello, 5 Aug. 1952, H.C. Greene (WIS); *S. nemoralis*, USA, Wisconsin, Dane Co., Madison, 27 Aug. 1945, H.C. Greene (WIS); *S. speciosa*, USA, Wisconsin, Columbia Co., Pacific Twp., near Swan Lake, 13 Sept. 1963, H.C. Greene (WIS); Dane Co., Madison, 21 Sept. 1943, H.C. Greene (WIS); 27 Aug. 1945, H.C. Greene (WIS); Univ. Wisconsin Arboretum, Dry woods, 59-1, 2 Oct. 1942, H.C. Greene (WIS); Iowa Co., Ridgeway Twp., Sect. 17, 5 Aug. 1964, H.C. Greene (WIS); Lafayette Co., near Platteville, 4 Aug. 1951, H.C. Greene (WIS); *S. uliginosa*, USA, Wisconsin, Columbia Co., Otsego, 17 Sept. 1947, H.C. Greene (WIS); *S. ulmifolia*, USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, Woods, 53-3, 23 Jul. 1944, H.C. Greene (WIS); *Solidago* sp. (as '*S. castrensis* fide L.H. Shinnery'), USA, Wisconsin, Juneau Co., Mauston, Sept. 1935, B.O. Dodge (WIS).

The conidiogenous loci in this species are quite distinct from those of true *Cladosporium* species and agree well with the concept of *Fusicladium* emend. (Schubert et al. 2003) by being denticle-like, apically truncate and unthickened. The species which is restricted to hosts of the tribe *Astereae* is distinguished from *Fusicladium artemisiae* in having solitary to only loosely aggregated conidiophores, catenate conidia and wider conidiogenous loci and hila. *F. virgaureae* usually has smaller, 0–1-septate conidia ($8\text{--}16 \times 3\text{--}6 \mu\text{m}$), formed in unbranched chains and possesses smaller conidiogenous loci and hila ($1\text{--}1.5 \mu\text{m}$ wide). *F. astericola* belongs to a group of *Fusicladium* species forming the conidia in unbranched or branched chains and having wide conidiogenous loci and hila, but differs from morphologically allied taxa in having shorter conidia (versus $13\text{--}40 \mu\text{m}$ long in *F. levierei* Magnus), narrower conidia (versus $5\text{--}10 \mu\text{m}$ wide in *F. effusum*) and solitary to only loosely arranged conidiophores which do not arise from stromata (versus loosely to densely fasciculate, arising from stromata in *F. euphorbiae*; solitary, arising from internal and external superficial hyphae or from swollen hyphal cells, or loosely fasciculate, arising from stromata in *F. humile*). Zhang et al. (2003) reported this species on *Kalimeris indica* (*Asteraceae*, *Astereae*) from China.

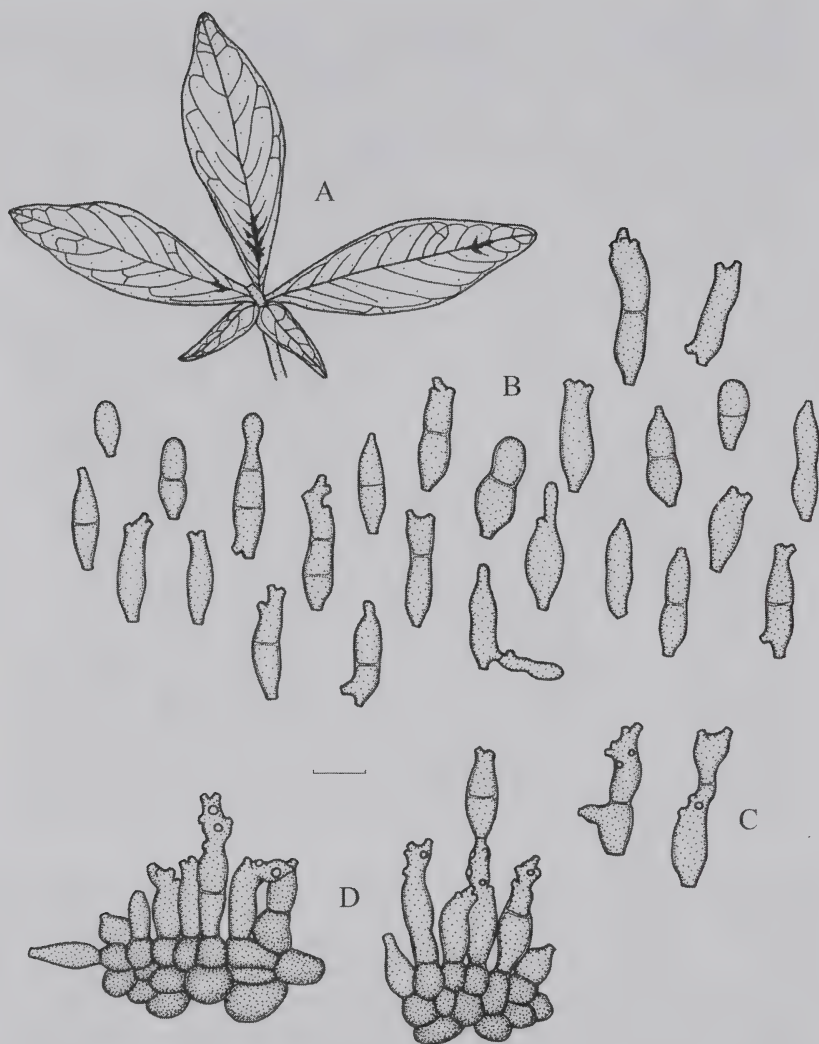


Fig. 4. *Fusicladium baptisiae*. Conidiophores and conidia from the type material. A – symptoms (original size), B – conidia, C – conidiogenous cells, D – fascicles of conidiophores. Bar = 10 μ m.

4. *Cladosporium baptisiae* H.C. Greene

Fig. 4

Fusicladium baptisiae (H.C. Greene) K. Schub. & U. Braun, **comb. nov.**

≡ *Cladosporium baptisiae* H.C. Greene, Amer. Midl. Naturalist 39(2): 456 (1948).

On living leaves, without forming distinct leaf spots. Colonies amphigenous, visible

as brown to somewhat reddish brown discolorations, mostly on leaf veins, especially on the midribs, scattered to effuse, densely caespitose, velvety. Mycelium internal, subcuticular, hyphae sparsely branched, 2–4 μm wide, septate, hyaline to subhyaline, smooth, walls slightly thickened. Stromata small to somewhat extended, 10–60 μm diam., composed of swollen, more or less angular, thick-walled cells, 4–11 μm wide, pale olivaceous brown to yellowish-brownish, smooth. Conidiophores fasciculate, in small, loose to somewhat dense sporodochial aggregations, arising from stromata, erumpent through the cuticle, erect, straight to sometimes slightly flexuous, cylindrical, conical to doliiform or irregularly shaped, unbranched, 5–35 $\times$ 3.5–7(–8) μm , 0–1-septate, sometimes slightly constricted at the septum, olivaceous-brown, smooth, walls only slightly thickened, somewhat attenuated towards the base, often only 3–4 μm wide. Conidiophores often reduced to conidiogenous cells or conidiogenous cells terminal, occasionally intercalary, proliferation sympodial, with a single to several conidiogenous loci, subdenticulate to denticulate, truncate, 1–2 μm wide, unthickened, not or only slightly darkened-refractive. Conidia catenate, in unbranched or branched chains, straight to slightly curved, fusiform, ellipsoid, subcylindrical to irregularly, 10–25(–31) $\times$ 4–7 μm , 0–1(–3)-septate, not or slightly constricted at the septa, pale olivaceous to olivaceous-brown, smooth, walls only slightly thickened, usually somewhat attenuated towards apex and base, apex rounded, truncate or slightly pointed, with up to 4 apical hila, base obconically truncate, hila 1–2 μm wide, unthickened, not or only slightly darkened-refractive.

MATERIAL EXAMINED: on *Baptisia leucophaea* (= *B. bracteata* var. *leucophaea*) (*Fabaceae*), USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, 14 Jul. 1947, H.C. Greene (WIS, syntype).

This species has to be transferred to *Fusicladium* since the conidiogenous loci are denticulate, truncate and unthickened, but not cladosporioid with a typical convex dome and raised rim (Roquebert 1981, David 1997). *Fusicladium brevipes* Ellis & Everh., *F. lathyrinum* (Ellis & Galloway) S. Hughes & Piroz., *F. pisicola* Linford and *F. psoraleae* (Ellis & Barthol.) S. Hughes & Piroz., the other species occurring on hosts belonging to the *Fabaceae* are quite distinct by always forming solitary conidia and having a different conidial surface ornamentation (coarsely verrucose in *F. lathyrinum*; asperulate, coarsely verrucose to echinulate in *F. pisicola* and smooth to coarsely verrucose, rugose in *F. psoraleae*). *F. martianoffianum* (Thüm.) K. Schub. & U. Braun is morphologically close to *F. baptisiae* but is easily distinguishable by forming distinct leaf spots, somewhat wider conidiophores (3–10 μm) and wider conidiogenous loci [1.5–2.5(–4) μm].

5. *Cladosporium brachyelytri* H.C. Greene

Fig. 5

Passalora fusimaculans [(G.F. Atk.) U. Braun & Crous] var. *barretoana* U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Ser. 1: 453 (2003).

= *Cladosporium brachyelytri* H.C. Greene, Trans. Wisconsin Acad. Sci. 53: 214 (1964), **syn. nov.**

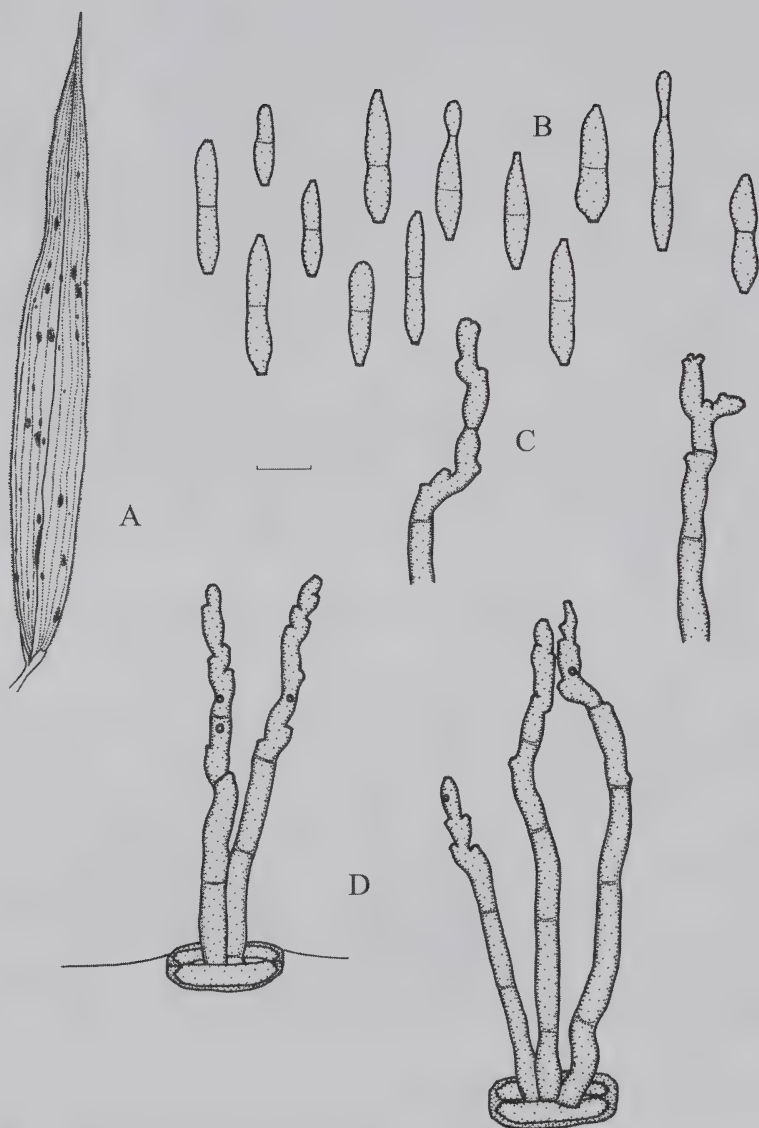


Fig. 5. *Passalora fusimaculans* var. *barretoana*. Conidiophores and conidia from type material of *C. brachyelytri*. A – infected leaves (original size), B – conidia, C – conidiogenous cells, D – small fascicles of conidiophores emerging through stomata. Bar = 10 μ m.

Leaf spots distinct, numerous, scattered, narrow, oblong to oblong-ellipsoid, 1–3(–7) mm long, up to 1 mm wide, reddish brown, surrounded by a paler reddish brown halo, often along leaf veins, occasionally confluent. Colonies hypophyllous, scattered, loosely villose, not densely caespitose, very pale, whitish to pale brown. Mycelium internal, usually substomatal. Stromata absent. Conidiophores solitary or in small, loose groups, arising from the internal mycelium, emerging through stomata, erect, straight to slightly flexuous, geniculate-sinuous, mostly unbranched, rarely apically branched, $48\text{--}130 \times 3.5\text{--}5.5 \mu\text{m}$, slightly attenuated towards the apex, septate, not or somewhat constricted at the septa, pale brown to pale olivaceous-brown, smooth, walls thickened. Conidiogenous cells integrated, terminal and intercalary, geniculate, $12\text{--}35 \mu\text{m}$ long, proliferation sympodial, with a single to several protuberant conidiogenous loci, subdenticulate, planate, $1.5\text{--}2 \mu\text{m}$ wide, thickened, darkened-refractive. Conidia in unbranched chains, straight, subcylindrical, subfusoid, rarely somewhat obclavate, $(6\text{--})14\text{--}27 \times 3\text{--}5(6) \mu\text{m}$, 1-septate, septum more or less median, not or very slightly constricted, subhyaline, smooth, walls unthickened or almost so, apex rounded, slightly pointed to mostly truncate, truncate at the base, hila protuberant, planate, $1\text{--}2 \mu\text{m}$ wide, thickened, darkened-refractive.

MATERIAL EXAMINED: on *Brachyelytrum erectum* (Poaceae), USA, Wisconsin, Sawyer Co., Flambeau State Forest near Oxbow, 22 Jul. 1964, H.C. Greene (WIS, syntype).

The variety *barretoana* was introduced for collections which are morphologically very close to *Passalora fusimaculans* but characterized by having significantly wider conidia (versus $1.5\text{--}3 \mu\text{m}$ wide in var. *fusimaculans*) (Crous & Braun 2003). The type collection of *Cladosporium piricularioides* Dearn. & House, a species on *Panicum* which has also been reduced to synonymy with var. *barretoana*, varies in forming stromata, loosely fasciculate conidiophores erumpent through the cuticle and somewhat larger, 0–2(–4)-septate conidia (Schubert & Braun 2005). It is the first record of this variety on *Brachyelytrum*.

6. *Cladosporium caducum* Davis

Fig. 6

Fusicladium caducum (Davis) K. Schub. & U. Braun, **comb. nov.**

≡ *Cladosporium caducum* Davis, Trans. Wisconsin Acad. Sci. 21: 298 (1924).

On living leaves, causing more or less subcircular to irregular discolorations or leaf spots, hypophyllous, indeterminate, 1–4 mm diam., numerous, scattered, at first pale olivaceous, later becoming yellowish to reddish-brown or brown, often confluent, when old forming on the upper leaf surface small, reddish-brown or even orange-brownish spots. Colonies hypophyllous, loosely scattered, dark brown. Stromata absent. Mycelium internal and external, superficial, hyphae creeping, branched, $1.5\text{--}3 \mu\text{m}$ wide, septate, not constricted at the septa, pale olivaceous to pale olivaceous-brown, smooth or almost so to somewhat irregularly rough-walled, walls thin to slightly thickened at the base of the conidiophores. Conidiophores solitary or aggregated in small loose groups of 2 or 3, but not fasciculate, arising from creeping hyphae, terminal or lateral, erect to subdecumbent, straight to slightly flexuous, unbranched or apically branched, $30\text{--}95(175) \times (3.5\text{--})4\text{--}5.5(6.5) \mu\text{m}$, septate, not or slightly constricted at the septa,

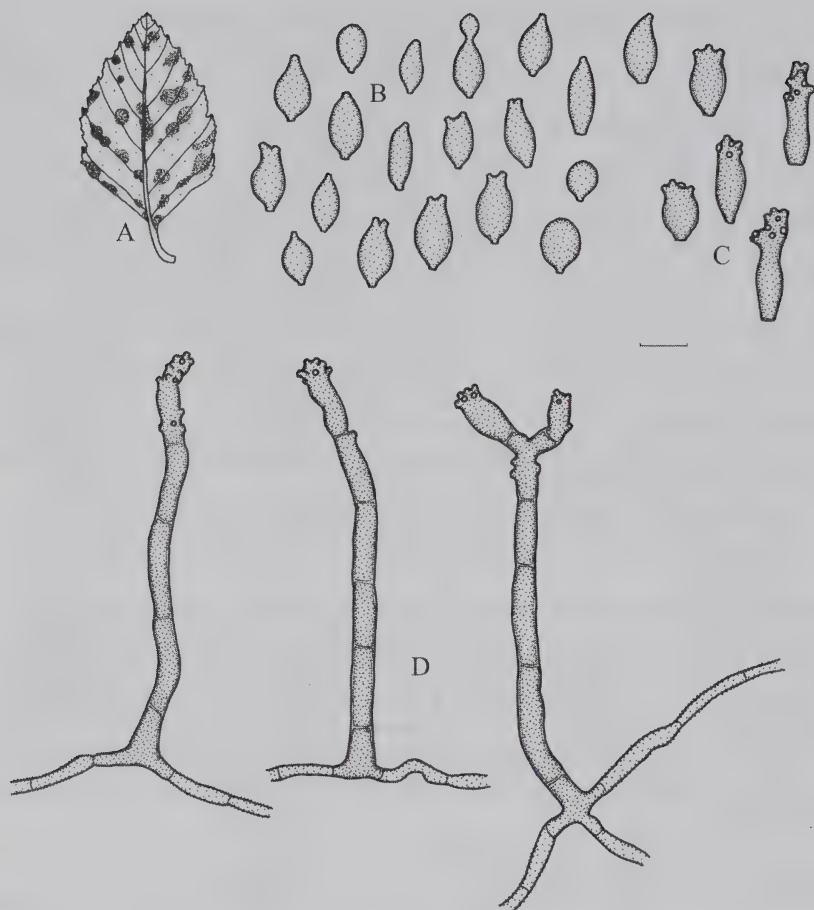


Fig. 6. *Fusicladium caducum*. Conidiophores and conidia from the type material. A – symptoms (original size), B – conidia, C – detached conidiogenous cells (ramoconidia), D – conidiophores arising from superficial hyphae. Bar = 10 μm .

medium to dark brown, somewhat paler towards the apex, smooth, thick-walled, not or slightly swollen at the base. Conidiogenous cells integrated, terminal to intercalary, almost ellipsoid to subcylindrical, 6–26 μm long, proliferation sympodial, with a single to several conidiogenous loci, subdenticulate to denticulate, truncate to slightly convex, 1–2(–2.5) μm wide, unthickened or almost so, mostly somewhat darkened-refractive, conidiogenous cells often detaching and then behaving like ramoconidia (s. str.), confusable with conidia but usually somewhat longer and narrower with several conidiogenous loci, a wider base and somewhat darker, concolorous with the tips of the conidiophores. Conidia in unbranched or branched chains, straight to only slightly curved, obovoid, limoniform, fusiform, acute, 6.5–18 $\times$ (4–)5–7(–8.5) μm , aseptate, very rarely with a single median septum, pale to medium olivaceous-brown, smooth,

walls unthickened or slightly thickened, attenuated towards apex and base, apex rounded, somewhat pointed or truncate, usually with a single or two hila, rarely with up to 5 hila, base more or less truncate, hila 1–2(–2.5) μm wide, unthickened or almost so, mostly somewhat darkened-refractive.

MATERIAL EXAMINED: on *Betula nigra* (*Betulaceae*), USA, Wisconsin, along the Wisconsin river (on the label 'Blue River'), 2 Jul. 1922, J.J. Davis (WIS, syntype); Avoca, 10 Sept. 1923, Gilbert & Davis (WIS); Blue River, 12 Sept. 1923, J.J. Davis (WIS); 14 Sept. 1923, J.J. Davis (WIS); Dane Co., Madison, Univ. Wisconsin Arboretum, 17 Aug. 1957, H.C. Greene (WIS); Old Nursery, 80-10, 7 Sept. 1952, H.C. Greene (WIS); Prairie du Sac, 21 Aug. 1922, J.J. Davis (WIS); Spring Green, 19 Jul. 1921, J.J. Davis (WIS).

The subdenticulate to denticulate, truncate, unthickened conidiogenous loci clearly discriminate this species from *Cladosporium* s. str. and *Stenella* Syd. They agree well with the concept of the genus *Fusicladium* to which this species has to be assigned. Species within the genus *Stenella* usually form external, superficial hyphae which are verruculose, but the conidiogenous loci are conspicuous, pileate to planate and somewhat thickened and darkened (Crous & Braun 2003). Within the genus *Fusicladium* there are only two species occasionally forming external, superficial hyphae. The mycelium of *F. humile* is also described to be rough-walled, but this species differs from *F. caducum* in having longer (10–29 μm), 0–2(–3)-septate conidia and wider loci [1–3(–3.5) μm]. *F. scillae* has mostly fasciculate narrower conidiophores [(1.5–)2–4 μm wide] and 0–3-septate, narrower (2.5–4 μm wide) conidia. *F. betulae* Aderh. and *F. scribnerianum* (Cavara) M.B. Ellis, which also occur on *Betula* spp., are quite distinct by forming solitary or fasciculate, 0–1-septate conidiophores arising from stromata, longer, mostly septate conidia [12–30(–34) μm long, (0–)1(–2)-septate in *F. betulae*; 11.5–29.5 μm long, 0–3-septate in *F. scribnerianum*] and wider conidiogenous loci and hila (2–3 μm).

7. *Cladosporium coreopsidis* H.C. Greene

Fig. 7

Fusicladium coreopsidis (H.C. Greene) K. Schub. & U. Braun, **comb. nov.**

≡ *Cladosporium coreopsidis* H.C. Greene, Trans. Wisconsin Acad. Sci. 45: 190 (1956).

On living leaves, petioles and stems, without discrete spots, but exhibiting areas of diffuse, dark purplish brown discolorations, often along the midribs and on petioles, but caespituli not confined to discolorations. Colonies amphigenous on leaves, scattered, loose, dark brown, short villose. Mycelium internal, subcuticular, hyphae branched, 1.5–4 μm wide, septate, with swellings and constrictions, subhyaline to pale brown, smooth, walls unthickened to slightly thickened, forming a loose network. Stromata absent. Conidiophores usually solitary, rarely loosely aggregated in pairs of two, arising from the internal mycelium, erumpent through the cuticle, erect, straight to slightly flexuous, somewhat geniculate-sinuuous, unbranched or rarely branched, more or less cylindrical, 30–65 $\times$ 3.5–5(–6) μm , septate, not or slightly constricted at the septa, dark brown, at the apex somewhat paler, smooth, thick-walled, not or only slightly swollen at the base. Conidiogenous cells integrated, terminal to intercalary, 9–35 μm

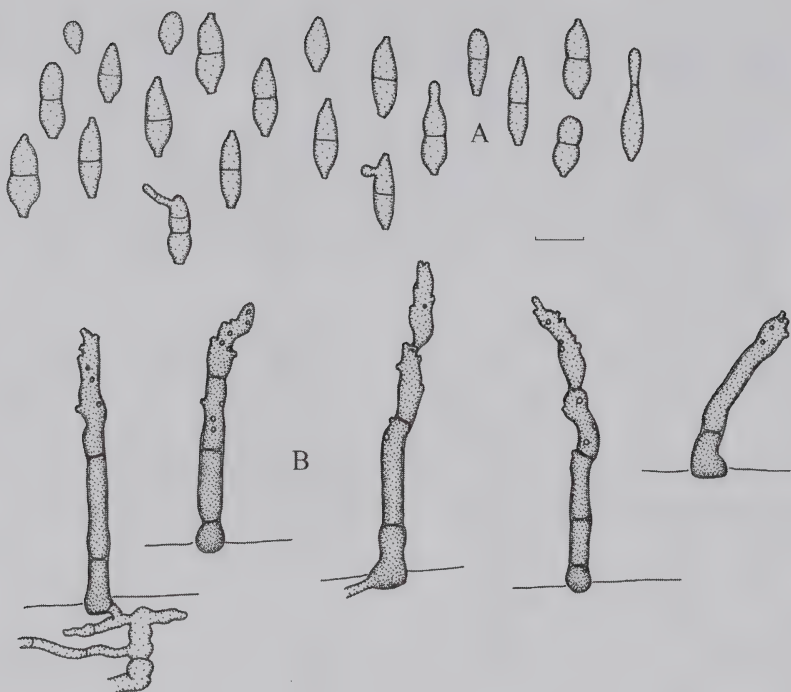


Fig. 7. *Fusicladium corepsidis*. Conidiophores and conidia from the type material. A – conidia, B – conidiophores. Bar = 10 μ m.

long, proliferation sympodial, cicatrized, with several, subdenticulate conidiogenous loci, truncate to slightly convex, 1–1.5(–2) μ m wide, unthickened, somewhat darkened-refractive. Conidia formed solitary or in unbranched short chains, straight, fusiform, obovoid to subcylindrical, 6–17(–20) $\times$ 3.5–5(–6) μ m, 0–1-septate, very rarely with two septa, not or slightly constricted at the more or less median septum, pale brown to pale yellowish brown, smooth, walls only slightly thickened, apex rounded, slightly pointed or truncate, truncate at the base, hila 1–1.5(–2) μ m wide, unthickened, somewhat darkened-refractive.

MATERIAL EXAMINED: on *Coreopsis palmata* (Asteraceae, Heliantheae), USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, 22 Jun. 1955, H.C. Greene (WIS); 22 Jul. 1957, H.C. Greene (WIS); Prairie, 100-3, 27 Jun. 1955, H.C. Greene (WIS, syntype); *Parthenium integrifolium*, USA, Wisconsin, Dane Co., Madison, Univ. Wisconsin Arboretum, 20 Aug. 1956, H.C. Greene (WIS); 30 Jul 1959, H.C. Greene (WIS); 15 Jul. 1960, H.C. Greene (WIS); Prairie, 101-7, 10 Aug. 1956, H.C. Greene (WIS).

This is the fourth *Fusicladium* species on a host belonging to the Asteraceae described herein. *F. corepsidis* is morphologically close to *F. astericola* but differs in having

somewhat smaller and narrower conidia usually formed in unbranched chains and numerous, significantly narrower loci. Furthermore, *F. coreopsidis* is restricted to hosts of the tribe *Heliantheae* whereas *F. astericola* only occurs on hosts of the tribe *Astereae*. Zhang et al. (2003) reported a collection from China on *Dahlia pinnata* (*Asteraceae*, *Heliantheae*).

The *Fusicladium* species on *Asteraceae* can be keyed out as follows:

1. Conidiophores fasciculate, arising from stromata, conidia solitary *F. artemisiae*
- 1.* Conidiophores solitary to loosely aggregated, but not fasciculate, stromata absent, conidia catenate, in unbranched or branched chains 2
2. Conidiogenous loci and hila (1–)1.5–3 μm wide, conidia (6–)9–27 μm long, in unbranched and branched chains *F. astericola*
- 2.* Conidiogenous loci and hila smaller, 1–1.5(–2) μm wide, conidia shorter, usually in unbranched chains, only very rarely in branched chains 3
3. Conidiogenous cells terminal and intercalary, cicatrized, with numerous, denticle-like, somewhat darkened conidiogenous loci *F. coreopsidis*
- 3.* Conidiogenous cells terminal, with a single or only up to four, not darkened conidiogenous loci *F. virgaureae*

8. *Cladosporium elsinoes* H.C. Greene

Dendryphiella infuscans (Thüm.) M.B. Ellis, Dematiaceous hyphomycetes: 500 (1971).

≡ *Cladosporium infuscans* Thüm., Rev. Mycol. (Toulouse) 1: 59 (1879).

≡ *Cladosporium elsinoes* H.C. Greene, Trans. Wisconsin Acad. Sci. 47: 127 (1958).

The identity of *Cladosporium elsinoes* with *Dendryphiella infuscans* has been pointed out by Heuchert et al. (2005).

9. *Cladosporium humile* Davis

Fusicladium humile (Davis) K. Schub. & U. Braun, IMI Descriptions of Fungi and Bacteria 152, No. 1520 (2002).

≡ *Cladosporium humile* Davis, Trans. Wisconsin Acad. Sci. 19: 702 (1919).

See Schubert et al. (2003) and Dugan et al. (2004).

10. *Cladosporium lysimachiae* H.C. Greene

Fusicladium lysimachiae (Guba) K. Schub. & U. Braun, Mycol. Progr. 4(2): 102 (2005).

≡ *Cladosporium lysimachiae* Guba, Rhodora 41: 513 (1939).

≡ *Cladosporium lysimachiae* H.C. Greene, Trans. Wisconsin Acad. Sci. 38: 232 (1946), nom. illeg., homonym, non *C. lysimachiae* Guba, 1939.

See Schubert & Braun (2005).

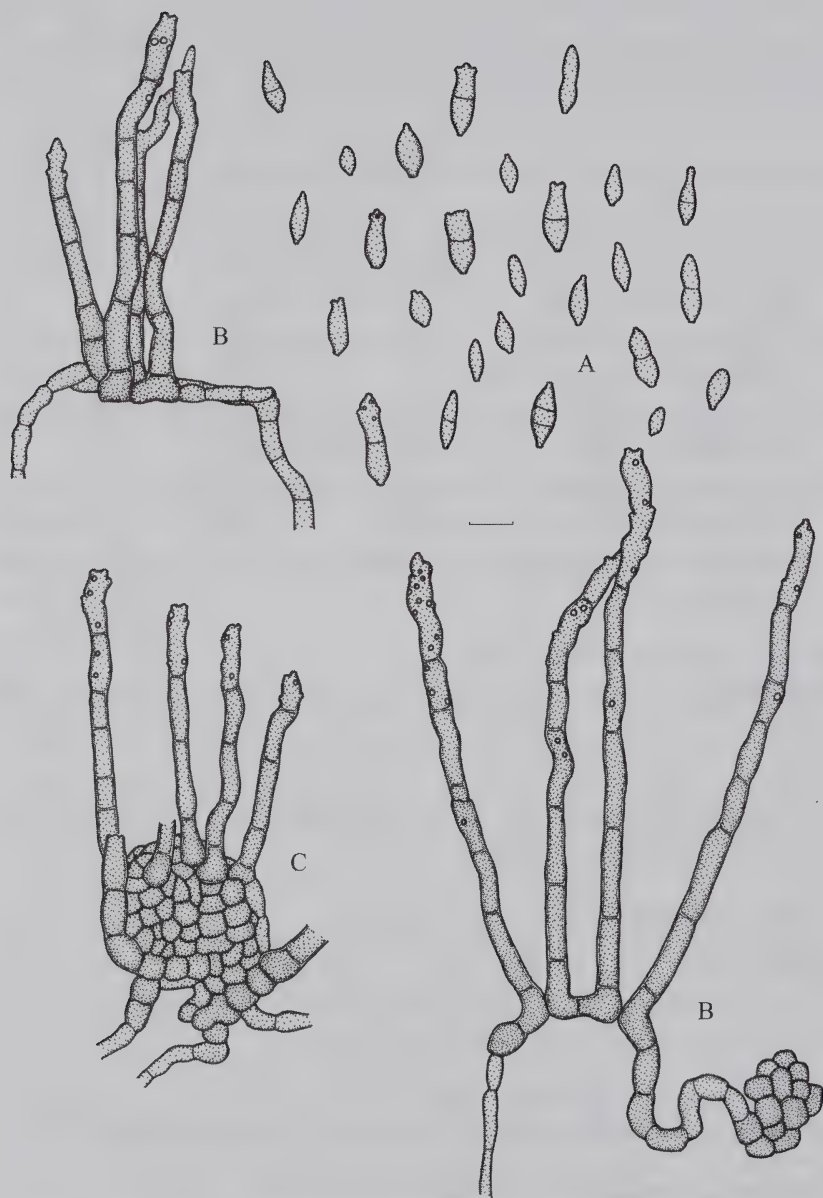


Fig. 8. *Fusicladium monardae*. Conidiophores and conidia from the type material. A – conidia, B – conidiophores arising from hyphae, C – conidiophores arising from stromata. Bar = 10 μ m.

11. *Cladosporium monardae* H.C. Greene

Fig. 8

Fusicladium monardae (H.C. Greene) K. Schub. & U. Braun, **comb. nov.**= *Cladosporium monardae* H.C. Greene, Amer. Midl. Naturalist 50(2): 508 (1953).

On living leaves, without distinct leaf spots or discolorations. Colonies amphigenous, loosely scattered, solitary or in small groups, but numerous, brown, villous. Mycelium internal and external, hyphae sparingly branched, 1.5–4 μm wide, septate, not or slightly constricted at the septa, subhyaline to pale brown or pale olivaceous-brown, smooth, walls unthickened or slightly thickened, often somewhat swollen at the base of the conidiophores and concolorous with them. Stromata small to more extended, subglobose or slightly flattened, loose to dense, pseudoparenchymatous, 20–70 μm diam., composed of swollen hyphal cells, subglobose to more or less angular or somewhat irregular, 4–8 μm wide, medium to dark brown or olivaceous-brown, smooth, thick-walled, stromata often connected by creeping hyphae. Conidiophores solitary or in small loose groups, arising from stromata or swollen, creeping hyphae, terminal or lateral, erumpent or more rarely superficial, erect, straight to slightly curved, somewhat geniculate-sinuous, unbranched, sporadically branched, 42–170 $\times$ 4–6 μm , septate, often slightly constricted at the septa, medium brown, young conidiophores somewhat paler, smooth, thick-walled, occasionally enteroblastically proliferating (percurrent, but not connected with conidiogenesis). Conidiogenous cells integrated, terminal to intercalary, cylindrical, 8–30 μm long, proliferation sympodial, with a single to several conidiogenous loci, not very conspicuous to subdenticulate, truncate or slightly convex, 1–1.5(–2) μm wide, unthickened, not to somewhat darkened-refractive. Conidia in unbranched or branched chains, straight, fusiform, obovoid, subfusoid to subcylindrical, 4.5–16(–20) $\times$ 3–5.5(–6) μm , 0–1(–3)-septate, not constricted or slightly constricted at the septa, pale olivaceous, smooth, walls unthickened or only slightly thickened, mostly somewhat attenuated towards apex and base, apex rounded, slightly pointed or truncate, hila truncate to slightly convex, 1–1.5(–2) μm wide, unthickened or almost so, somewhat darkened-refractive.

MATERIAL EXAMINED: on *Monarda punctata* (Lamiaceae), USA, Wisconsin, Dane Co., Madison, 3 Sept. 1954, H.C. Greene (WIS); Univ. Wisconsin Arboretum, Prairie, 81-10, 10 Aug. 1952, H.C. Greene (WIS, syntype).

On account of the denticle-like, unthickened conidiogenous loci, this species has to be excluded from *Cladosporium* s. str. (David 1997) and reallocated to *Fusicladium* emend. (Schubert et al. 2003). It is the first member of *Fusicladium* on a host belonging to the Lamiaceae. *F. orchidis* (E.A. Ellis & M.B. Ellis) K. Schub. & U. Braun, which was also described as a *Cladosporium* species, is morphologically similar but distinct in causing definite leaf spots, lacking stromata, having somewhat wider conidiogenous loci [1.5–2(–3) μm wide] and 0–3-septate conidia (Schubert & Braun 2004).

12. *Cladosporium stipae* H.C. Greene

Fig. 9

Stenella stipae (H.C. Greene) K. Schub. & U. Braun, **comb. nov.**= *Cladosporium stipae* H.C. Greene, Trans. Wisconsin Acad. Sci. 41: 127 (1952).

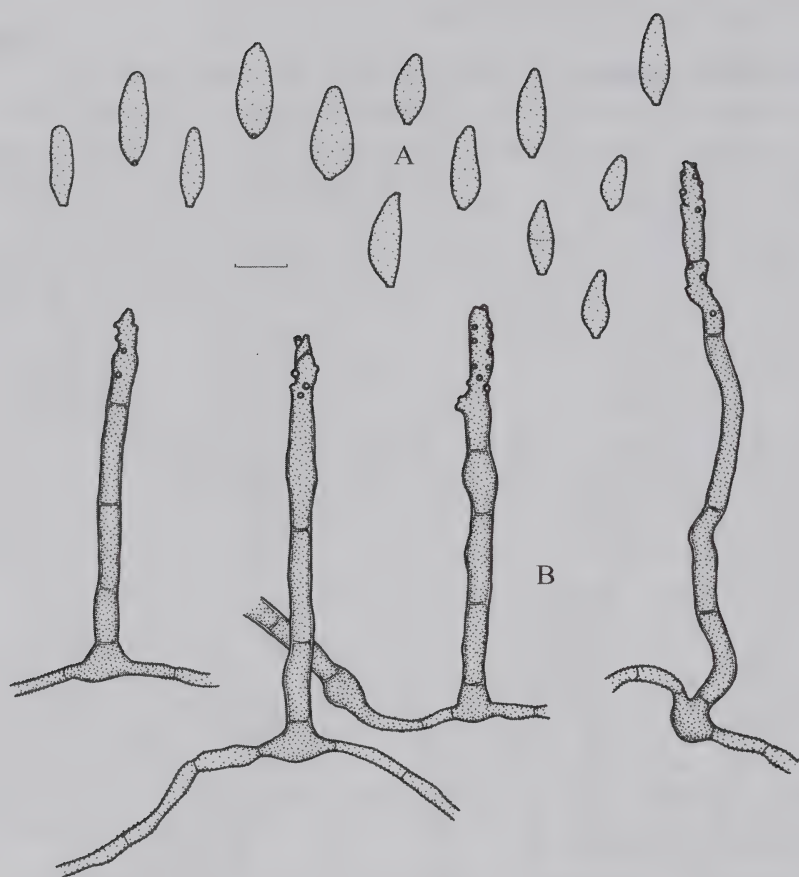


Fig. 9. *Stenella stipae*. Conidiophores and conidia from the type material. A – conidia, B – conidiophores. Bar = 10 μ m.

On living leaves, without conspicuous discolorations or leaf spots. Colonies hypophyllous, scattered, loose, straight to decumbent, dark brown, villose to bristle-like, confined to the incurved, strongly ribbed side of the leaf. Mycelium external, superficial, hyphae creeping, branched, 1.5–4 μ m wide, septate, not or slightly constricted at the septa, subhyaline to pale olivaceous, smooth or almost so (usually near and at the base of the conidiophores) to somewhat irregularly rough-walled, walls unthickened or slightly thickened at the base of the conidiophores. Conidiophores solitary, arising from superficial hyphae, terminal or lateral, erect, straight to slightly flexuous, not or somewhat geniculate-sinuous, subacuminate, unbranched, 40–145 $\times$ 3.5–5(–6) μ m, septate, medium brown, sometimes somewhat paler at the apex, smooth or almost so, walls somewhat thickened, often swollen at the base, occasionally enteroblastically proliferating (percurrent, but not connected with conidiogenesis). Conidiogenous cells

integrated, terminal and intercalary, 9–40 μm long, proliferation sympodial, with mostly numerous conspicuous conidiogenous loci, somewhat crowded near the apex, 1–1.5(–2) μm wide, slightly thickened and darkened-refractive. Conidia solitary or rarely in unbranched, short chains, straight, subfusoid-ellipsoid, 11–21 $\times$ (3.5–)4–7(–8.5) μm , 0(–1)-septate, very pale olivaceous, smooth to occasionally minutely verruculose, thin-walled, slightly attenuated towards apex and base, apex somewhat pointed, hila prominent, usually planate, 1–1.5(–2) μm wide, slightly thickened, darkened-refractive.

MATERIAL EXAMINED: on *Stipa spartea* (= *Hesperostipa spartea*) (*Poaceae*), USA, Wisconsin, Dane Co., Madison, 11 Aug. 1952, H.C. Greene (WIS); Univ. Wisconsin Arboretum, Oak opening, 97–9, 6 Sept. 1951, H.C. Greene (WIS, syntype); near Springfield Corners, 12 Aug. 1952, H.C. Greene (WIS); Green Co., near Brodhead, 8 Aug. 1950, H.C. Greene (WIS); Brodhead, 9. Aug. 1952, H.C. Greene (WIS).

This species is characterized by having somewhat irregularly rough-walled superficial creeping hyphae and slightly thickened, darkened conidiogenous loci without any dome and raised rim. Based on these characteristics, *Cladosporium stipae* must be placed in *Stenella*. This is the first *Stenella* on a host belonging to the *Gramineae*. There is no morphologically comparable species.

13. *Cladosporium trichophilum* H.C. Greene

Fig. 10

Passalora nopomingensis (B. Sutton) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*, CBS Biodiversity Ser. 1: 462 (2003).

= *Mycovellosiella nopomingensis* B. Sutton, Mycol. Pap. 132: 77 (1973).

= *Cladosporium trichophilum* H.C. Greene, Amer. Midl. Naturalist 48(3): 756 (1952), nom. illeg., homonym, non *C. trichophilum* Petr. & Cif., 1932, **syn. nov.**

On living leaves, amphigenous, at first as small discolorations or spots, angular-irregular, yellowish brown to medium brown dotted, paler brown at the lower leaf surface, becoming distinct spots, angular-irregular, 2–9 mm diam., on the upper leaf surface dark brown, clearly limited, but without a definite margin, surrounded by a subcircular to oval, yellowish-brown to ochraceous halo, paler greyish brown or brown below. Colonies always hypophyllous, mostly on spots and discolorations but not restricted to them, climbing leaf hairs, pale to medium brown, villose. Mycelium external, superficial, hyphae branched, 1–2 μm wide at the base, becoming 3–4 μm wide distally, septate, subhyaline to very pale brown, smooth, unthickened, at first creeping over the leaf surface and covering it like a cobweb, later growing upwards between leaf hairs and frequently climbing them, loosely to densely aggregated, forming ropes. Conidiophores arising terminally or laterally from superficial hyphae, loosely to densely aggregated, entwining leaf hairs, erect, straight to flexuous or somewhat irregular, somewhat geniculate-sinuous, unbranched to branched, 12–60 $\times$ 3.5–6(–8) μm , 0–2-septate, pale to pale medium brown, smooth, walls only slightly thickened, somewhat wider at the base. Conidiophores reduced to conidiogenous cells or conidiogenous cells integrated, terminal to intercalary, 12–42 μm long, proliferation sympodial, polyblastic, with

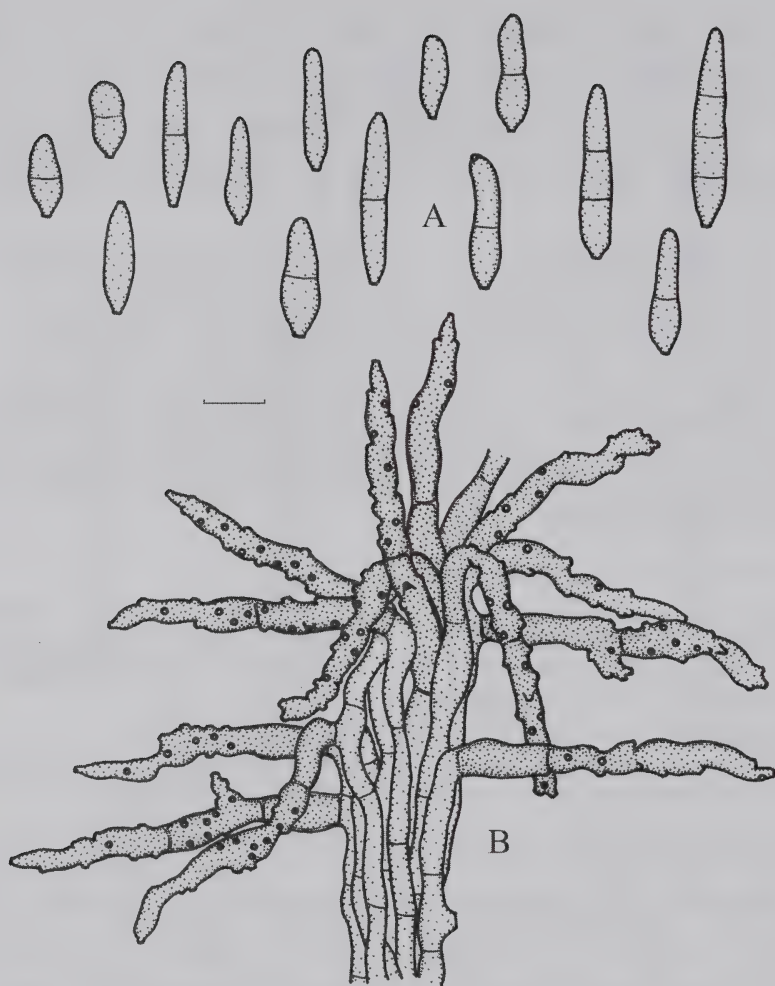


Fig. 10. *Passalora nopomingensis*. Conidiophores and conidia from type material of *C. trichophilum*. A – conidia, B – conidiophores climbing leaf hairs. Bar = 10 μ m.

numerous conspicuous conidiogenous loci, truncate, 1–1.5(–2) μ m wide, thickened, darkened-refractive. Conidia solitary or in short, unbranched chains, straight to slightly curved, cylindrical to somewhat obclavate, 12–32 $\times$ 3.5–5.5(–7) μ m, 0–1(–3)-septate, not or slightly constricted at the septa, subhyaline to very pale brown, smooth, walls unthickened or slightly thickened, apex obtuse to slightly attenuated or rarely truncate, base truncate, hila 1–1.5(–2) μ m wide, thickened, darkened-refractive.

MATERIAL EXAMINED: on *Lonicera hirsuta* (Caprifoliaceae), USA, Wisconsin, Rusk Co., Hawkins, 26 Aug. 1918, J.J. Davis (WIS, syntype).

The type collection of *Cladosporium trichophilum* agrees well with the characteristic features of *Passalora nopomingensis* (Sutton 1973) and has to be reduced to synonymy with the latter species. It only varies in having somewhat longer conidiophores and conidiogenous cells with numerous protuberant scars and somewhat wider, mostly only 0–1(–3)-septate conidia. *Lonicera hirsuta* is a new host species and *P. nopomingensis*, until now only known from Canada, is new to the USA. Shvartsman et al. (1975) reported two collections on *Lonicera altmannii* and *L. tatarica* from Kazakhstan and gave a short description of the species (conidia catenate, ellipsoid, ovoid, subglobose, $8.7\text{--}18.7 \times 4.5\text{--}7.5 \mu\text{m}$, 0–1-septate, mycelium immersed, conidiophores fasciculate). However, based on this description these collections are probably not conspecific with *C. trichophilum* H.C. Greene.

Acknowledgements

I am much obliged to the director and curator of WIS for allowing me to examine types and other collections in their keeping. I am very grateful to Dr. F. Dugan, Western Regional Plant Introduction Station, USDA-ARS, Washington State University, Pullman, USA, and Dr. C. F. Hill, National Plant Pest Reference Laboratory, Ministry of Agriculture & Forestry, Auckland, New Zealand, for critical comments on the manuscript, and for acting as a presubmission reviewer, respectively. My sincere thanks are due to Prof. U. Braun for giving constructive advice and comments.

Literature Cited

- Beck A, Ritschel A, Schubert K, Braun U, Triebel D. 2005. Phylogenetic relationships of the anamorphic genus *Fusicladium* s. lat. as inferred by ITS nrDNA data. *Mycol. Progr.* **4**(2): 111–116.
- Bensaude M, Keitt GW. 1928. Comparative studies of certain *Cladosporium* diseases of stone fruits. *Phytopathology* **18**(4): 313–329.
- Braun U. 1998. A monograph of *Cercospora*, *Ramularia* and allied genera (Phytopathogenic Hyphomycetes) Vol. 2. IHW-Verlag, Eching.
- Braun U. 2001. *Cladosporium exoasci*, *C. exobasidii* and some allied species. *Schlechtendalia* **7**: 53–58.
- Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. *CBS Biodiversity Ser.* **1**: 1–571.
- David J. 1997. A contribution to the systematics of *Cladosporium*. Revision of the fungi previously referred to *Heterosporium*. *Mycol. Pap.* **172**: 1–157.
- Dugan FM, Schubert K, Braun U. 2004. Check-list of *Cladosporium* names. *Schlechtendalia* **11**: 1–103.
- Heuchert B, Braun U, Schubert K. 2005. Morphotaxonomic revision of fungicolous *Cladosporium* species (hyphomycetes). *Schlechtendalia* **13**: 1–78.
- Holmgren PK, Holmgren NH, Barlett LC. 1990. Index herbariorum, Part. 1: The Herbaria of the World. 8th edn. *Regnum vegetabile* **120**: 1–163.
- Onďřej M. 1971. Houby rodu *Fusicladium* Bonorden, tvořící konidie v řetězích (Hyphomycetes, Fungi imperfecti). *Česká Mykol.* **25**(3): 165–172.
- Roquebert MF. 1981. Conidiogenèse et conidiophores chez *Cladosporium herbarum* (Pers.) Link et *Cladosporium cladosporioides* (Fresen.) de Vries. *Cryptog. Mycol.* **2**: 269–278.
- Schubert K, Braun U. 2004. Taxonomic revision of the genus *Cladosporium* s. lat. 2. Morphotaxonomic examination of *Cladosporium* species occurring on hosts of the families *Bignoniaceae* and *Orchidaceae*. *Sydowia* **56**(2): 296–317.

- Schubert K, Braun U. 2005. Taxonomic revision of the genus *Cladosporium* s. lat. 1. Species reallocated to *Fusicladium*, *Parastenella*, *Passalora*, *Pseudocercospora* and *Stenella*. Mycol. Progr. **4**(2): 101–109.
- Schubert K, Ritschel A, Braun U. 2003. A monograph of *Fusicladium* s.lat. (hyphomycetes). *Schlechtendalia* **9**: 1–132.
- Sutton BC. 1973. Hyphomycetes from Manitoba and Saskatchewan, Canada. Mycol. Pap. **132**: 1–143.
- Shvartsman SR, Vasyagina MP, Byzova ZM, Filimonova NM. 1975. Nesovershennye griby – Fungi imperfecti (Deuteromycetes). Monilial'nye – Moniliales. Vol. 8, part 2, of Series 'Flora sporovykh rastenij Kazakhstana'. 'Nauka' Publishing House, Alma-Ata.
- Zhang ZY, Liu YL, Zhang T, Li TF, Wang G, Zhang H, He YH, Peng HH. 2003. Flora Fungorum Sinicorum, Vol. **14**, *Cladosporium*, *Fusicladium*, *Pyricularia*. Beijing.

Revision of three species of *Tricholoma* reported from China

H. DENG^{1,2} & Y. -J. YAO^{1*}

yaoyj@sun.im.ac.cn

¹Systematic Mycology and Lichenology Laboratory, Institute of Microbiology
Chinese Academy of Sciences, Beijing, 100080, China

²Graduate School of the Chinese Academy of Sciences

Abstract—Three species of *Tricholoma* reported from China are revised. The occurrence of *T. sulphureum* in China is confirmed. Specimens of *T. sulphureum* from China were studied and described in detail, and comparisons with European collections are presented. The occurrence of both *T. caligatum* and *T. magnivelare* in China is not confirmed. The description of the former from China is not supported by voucher specimens and does not match representative specimens of *T. caligatum* from Europe; the latter, initially named *T. ponderosum*, is supported by a voucher specimen, but this is here re-identified as a species of *Amanita*.

Key words—Chinese records, distribution, *Tricholomataceae*

中文摘要

本文报道对口蘑属3个种的研究结果, 确认了硫色口蘑 (*T. sulphureum*) 在中国的分布, 排除了两个中国的记录, 即欧洲口蘑 (*T. caligatum*) 和美洲口蘑 (*T. magnivelare*)。对中国的硫色口蘑标本进行了详细的描述, 并与欧洲的材料进行了比较。中国文献中所描述的欧洲口蘑的特征与欧洲文献的记录和来自欧洲的标本不符, 而对中国唯一的称为美洲口蘑的标本研究结果却表明其为鹅膏属 (*Amanita*) 的成员, 故排除了这两种口蘑在中国的分布。

Introduction

The Matsutake mushroom has been considered to symbolize fertility, and by extension, good fortune and happiness in Japan for more than a millennium (Hosford et al 1997, Rawe 1997, Murata et al. 1999). It is an autumn delicacy and its production is increasing in Asia and in North America. The world market in Matsutake is estimated at US\$500 million (Hall et al. 2003). There are several scientific names associated with Matsutake. Among them, *Tricholoma magnivelare* (Peck) Redhead (= *T. ponderosum* (Peck) Singer) from North America, called American Matsutake, white Matsutake, pine mushroom or tanoak mushroom (Hosford et al. 1997), has been exported in large quantity to the Japanese market, where it can reach prices of US\$220/kg (Rowe 1997). In the 1990's,

*Author for correspondence

Canada and USA exported about 500 to 700 t/year of *T. magnivelare* to Japan and, in one popular spot in Oregon, 18 t were collected daily and pickers were paid US\$44 per kilogram (Wang et al. 1997).

T. magnivelare has an east-west distribution across Canada, also occurring southwards, along the Appalachian, Rocky, Cascade and Pacific Coast mountain ranges, into the USA and Mexico (Hosford et al. 1997, Wang et al. 1997, Lim et al. 2003). However, *T. magnivelare* (as *T. ponderosum*) has also been reported from China (Comprehensive Scientific Expedition to the Tibetan Plateau 1996) with a distribution extending into Asia.

Tricholoma caligatum (Viv.) Ricken, originally described from Europe, is a species close to the *Tricholoma matsutake*-complex. It is one of the most important edible species in the genus *Tricholoma* and, before *Armillaria matsutake* S. Ito & S. Imai (= *Tricholoma matsutake* (S. Ito & S. Imai) Singer) was erected in 1925, the Asian species was also classified as *T. caligatum* (Wang et al. 1997). *Tricholoma caligatum* has been reported from southern France, Germany, Italy, the eastern and south-eastern parts of Spain, and Greece, as well as from adjacent regions, in particular Algeria, Morocco and Turkey (Kytövuori 1988, Wang et al. 1997, Zervakis et al. 1998, Kalmis, personal communication). It was also recently reported from China (Mao 1998, 2000) but with no specimens cited.

In a survey of *Tricholoma* in China, *T. sulphureum* (Bull.) P. Kumm. was included by the present authors (Deng et al. 2004). This is a common species in Europe (Bon 1984, 1987, Zervakis et al. 1998, Saitta et al. 2003, Perini et al. 2004), growing with beech, oak, holly or other broadleaved trees (Bon 1984, 1987). *Tricholoma sulphureum* has also been reported from China in recent years, but without any cited specimens or supporting description (Mao et al. 1993, Mao 1998, 2000, Comprehensive Scientific Expedition to the Tibetan Plateau 1996).

To clarify the occurrence of these species in China, examination of available material was carried out. Specimens deposited under these three names in Herbarium of Cryptogams, Kunming Institute of Botany, Academia Sinica (HKAS) and Mycological Herbarium, Academia Sinica (HMAS), were studied. Specimens from the Herbarium, Botanical Museum, University of Copenhagen (C), the Herbarium, Royal Botanic Gardens, Kew (K), National Herbarium of Netherlands (L) and University of Michigan Fungus Collection (MICH), were also studied for comparison purposes. It is concluded here that *T. caligatum* and *T. magnivelare* should be removed from the species list of *Tricholoma* in China, whilst the occurrence of *T. sulphureum* in China is confirmed and material described in detail.

Taxonomy

Tricholoma caligatum (Viv.) Ricken, *Blätterpilze*Deutschl.: 331 (1914).
= *Armillaria caligata* Viv., *Fung. Italia*: pl. 35 (1834).

Pileus 2.4–10.6 cm diam., convex; surface blackish brown to fuscous at centre, paling towards the margin, with concentric, appressed, dark brown scales; margin straight or decurved. *Lamellae* sinuate, cream, 3.0–4.0 mm wide, close, with lamellulae. *Stipe* 2.5–11.0 cm long, 0.8–2.0 cm thick, cylindrical, solid, fibrous; surface whitish above the annulus, concolourous with the pileus below the annulus. *Annulus* situated towards

the stem apex, ascending, persistent, membranous, concolourous with the pileus, sheathing the stipe. *Context* white, fleshy, thin, comprising repent, thin-walled hyphae, 5.0–18.0 μm diam, inflating to 33 μm diam., clamp-connexions absent. *Spore deposit* white. *Basidiospores* 4.5–8.0 $\times$ 4.0–7.0 μm , subglobose to ellipsoid, hyaline, inamyloid, thin-walled, smooth. *Basidia* 27–44 $\times$ 5.0–8.5 μm , clavate, bearing four sterigmata, subhyaline. *Lamella-edge* fertile. *Hymenophoral trama* regular, 150–250 μm wide, with hyaline hyphae, 5.0–13.0 μm diam. *Subhymenial layer* 10.0–13.0 μm thin, narrow, interwoven. *Pileipellis* a thick cutis, 100–200 μm thick, of closely interwoven hyphae, 3.0–12.0 μm diam., thin-walled, hyphae with yellowish pigment.

Specimens examined: **France:** Martignat, 4 Oct. 1957, Piané & Huijsman, L 0354432; Provence, Carqueiranne near Rounom l'ond der Oiseaux, Dec. 1959, L 0354433; Herant, Pic St Loup, 18 Nov. 1999, E. W. Brown, K(M) 77912. **Spain:** Barcelona, Dosrius, 2 Nov. 1986, F. D. Calonge, K(M) 16030. **Italy:** Toscana, Foreste Demaniali del Berignone, Monte Soldano, under *Cupressus* sp., 8 Nov. 1996, M. Christensen, MC96-349, in C.

The above description is based on the specimens listed from Europe.

Tricholoma caligatum is close to *T. magnivelare* and *T. matsutake*, which all have an annulus on the stipe. However, *T. caligatum* differs from *T. magnivelare* most notably in its coloured pileus when young and cinnamon-brown to vinaceous brown when mature (Smith 1979), and from *T. matsutake* by its smaller pileus, spores and basidia, as well as the darker pileus (Kytövuori 1988).

This species was reported twice from China by the same author (Mao 1998, 2000) based on his own collections, although no specimens were cited. In addition, the specimens described in the Chinese literature were lost (Mao, personal correspondence) and there is no other specimen of this species available from China. According to Mao's description, the sizes of pileus and basidiospores are similar in appearance to that of *T. caligatum* in Europe, but the dry surface of the pileus of *T. caligatum* described by Mao is different from the viscid pileus reported in the European literature (Bon 1984, 1987, Kytövuori 1988). The white scales on the surface above the annulus reported by Mao (1998, 2000) have not been observed on the European specimens listed above and they are not mentioned by European authors, e.g. Bon (1984, 1987) and Kytövuori (1988). Furthermore, some microscopic characters, such as the hymenial layer and pileipellis, were not described in the Chinese record. The *Tricholoma caligatum* group in Europe has been recognized as consisting of three species: *T. nauseosum* (Blytt) Kytövuori, *T. dulciolens* Kytövuori and *T. caligatum* s. s.; the last is considered to be a meridional species occurring most commonly around the western part of the Mediterranean (Kytövuori 1988). According to the results of the present study, there is no evidence supporting the report of *T. caligatum* in China. Therefore, it should be excluded from the Chinese list of *Tricholoma* species.

Tricholoma magnivelare (Peck) Redhead, Trans. Mycol. Soc. Japan 25: 6 (1984).
 = *Agaricus magnivelaris* Peck, Annual Rep. New York State Mus. 29: 66 (1878, nom. nov. for *Agaricus ponderosus* Peck).
 = *Agaricus ponderosus* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 42 (1873) nom. illeg., non *Agaricus ponderosus* Pers., Mycol. eur. 3: 116 (1828).

≡*Armillaria ponderosa* (Peck) Sacc., Syll. fung. 5: 58 (1887) nom. nov. for *Agaricus ponderosus* Peck.

≡*Tricholoma ponderosum* (Peck) Singer, Lilloa 22: 227 (1940) [1951].

Pileus 5.0–10.5 cm diam., nearly plane when expanded; surface at first white, then light ochraceous-salmon, smooth, glabrous or fibrillose; margin straight or decurved. *Lamellae* sinuate, light buff, 3.0–7.0 mm wide, close, with lamellulae. *Stipe* 5.5–12.0 cm long, 1.5–2.5 cm thick, cylindrical, solid, fibrous; surface whitish above the annulus, with cinnamon, fulvous to date-brown scales below the annulus. *Annulus* white above and vinaceous brown below, persistent, membranous, above the middle of the stem. *Context* white, fleshy, thin, comprising repent, thin-walled hyphae, 2.0–8.5 μm diam., clamp-connexions absent. *Spore deposit* white. *Basidiospores* 6.0–8.0 $\times$ 4.0–6.0 μm , subglobose to ellipsoid, hyaline, inamyloid, thin-walled, smooth. *Basidia* 25–45 $\times$ 6.0–10.0 μm , clavate, bearing four sterigmata, hyaline. Lamella-edge fertile. *Hymenophoral trama* regular, 100–300 μm wide, with hyaline hyphae, 5.0–9.0 μm diam. *Subhymenial layer* 10.0–19.0 μm thin, narrow, interwoven. *Pileipellis* a repent cutis of closely interwoven hyphae, 2.5–10.0 μm diam., thin-walled.

Specimens examined: USA: California, Siskiyou Co., at forest, 11 Nov. 1937, A.H. Smith 8615, MICH 00042422; California, Humboldt Co., Samon Peninsula, near Arcata, in Lanphere's *Pinus* woods, 27 Dec. 1956, H. Lanphere 28, MICH 00042403; Ida, Bonner Co., north end of Priest Lake, 5 Oct. 1964, A.H. Smith 71052, MICH 00042425; Michigan, Marquette Co., Lake Levasseur (Mud Lake), under *Pinus banksiana*, 2 Oct. 1920, K. A. Harrison 9924, MICH 00042426; Michigan, Chippewa Co., Whitefish Pt., scattered on sand dunes, 16 Sep. 1957, R.L. Shaffer 1945, MICH 00042427; Michigan, Marquette Co., near Lake Le Vasseur, under *Pinus resinosa*, 30 Sep. 1970, K. A. Harrison 9893, MICH 00042421; New York, Essex Co., in mixed woods, decorticated log, 18 Jul. 1954, R.L. Shaffer 330, MICH 00042430; Nova Scotia, Kings Co., Aldershot, under *Pinus* sp., 2 Oct. 1969, K.A. Harrison 8710, MICH 00042428; Oregon, Lane Co., near Florence, in sand under *Pinus contorta* along the sea coast, 28 Nov. 1932, S. M. Zeller 5597, MICH 00042401; Oregon, Deschutes Co., McKenzie Pass, 44°15.6'N, 121°48.52'W, under *Pinus* sp., 21 Oct. 1937, A.H. Smith 8034, MICH 00042398; Oregon, Klamath Co., Odell Lake, 43°34.38'N, 121°59.83'W, in mixed conifer forest Alt. 4800 ft, 19 Sep. 1943, F.P. Sipe 300, MICH 00042042; Oregon, Clackamas, East Fork Salmon River, under *Pinus* sp., 28 Sep. 1944, A.H. Smith 19180, MICH 00042400; Oregon, Clackamas Co., 15 Oct. 1945, W.B. Gruber 682, MICH 00042423; Oregon, Grants Pass Josephine Co., under oak-pine, 18 Nov. 1956, A.H. Smith 55818; Washington, Clallam Co., Olympics 160 t, under pine forest, 30 Sep. 1941, A.H. Smith 17436, MICH 00042424; Washington, Pierce Co., near Longmire, Mount. Rainier National Park, 46°45'N, 121°48.68'W, 28 Sep. 1954, A.H. Smith 48125, MICH 00042399.

The above description is based on the listed specimens from the USA. This species is characterized by the white pileus when young and the existence of an annulus on the stipe. It has been reported only from America (North to Central America). It is distinguished from *T. matsutake* particularly by lacking a coloured pileus when young (Smith 1979).

The American Matsutake, or pine mushroom, was once commonly cited as either *Armillaria ponderosa* (Peck) Sacc. (Zeller & Togashi 1934, Smith 1979) or *Tricholoma*

ponderosum (Peck) Singer (Singer 1951). However, after reviewing the changes in the names made by different authors, Redhead (1984) proposed the new combination *T. magnivelare*.

Tricholoma magnivelare was introduced to the Chinese literature (as '*T. ponderosa*'), along with other 'Matsutake' names, as a species confined to North America (Zang 1990). However, it was later reported to occur in China as well (as '*T. ponderosum*'), supported by a collection from Yunnan (Comprehensive Scientific Expedition to the Tibetan Plateau 1996). Examination of the specimen (Yunnan Province, Dianzhong, November 1983, D. G. Ji, HKAS 12091) shows it is probably a species of *Amanita*. The specimen has a pileus 12.5 cm diam. and a stipe 21 cm long and 3.5 cm thick. The stipe seems to have been cut at the base. In addition, volval remnants at the margins of the pileus and on the lamellae, the striate margin surface of the pileus and the ovoid to globose spores found in the specimen are typical characters of an *Amanita* species. Since this is the only record of *T. magnivelare* (as '*T. ponderosum*') in China, the species should no longer be regarded as Chinese.

Tricholoma sulphureum (Bull.) P. Kumm., Führer Pilzk.: 133 (1871). **Fig. 1**
 ≡ *Agaricus sulphureus* Bull., Herb. France: pls. 168, 545 (1783): Fr., Syst. mycol. 1: 110 (1821).

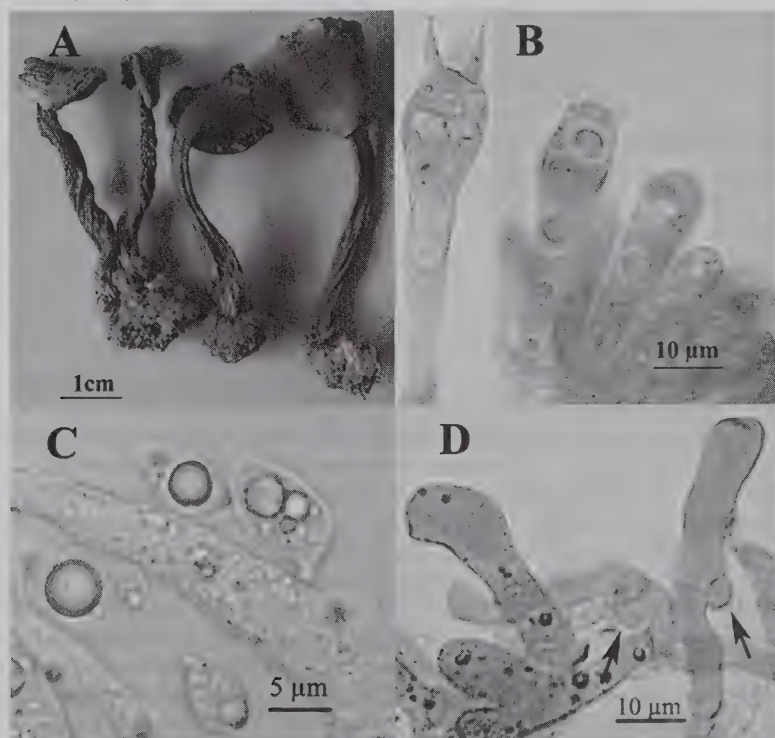


Fig. 1. *Tricholoma sulphureum* (HMAS 63205). A. badiocarps; B. basidia; C. basidiospores; D. arrows showing clamp-connexions.

Pileus 1.4–2.0 cm diam., plane; surface sulphur-yellow, smooth, glabrous; margin straight or decurved. *Lamellae* sinuate, yellow, 2.0–3.0 mm wide, close, somewhat decurved when dry, with lamellulae. *Stipe* 4.5–6.0 cm long, 0.4–1.0 cm thick, cylindrical with a slightly swollen base, solid, fibrous; surface sulphur-yellow and with striae when dry. *Annulus* absent. *Context* yellow, fleshy, thin, comprising repent, thin-walled hyphae, 3.0–7.0 μm diam, inflating to 20 μm diam., clamp-connexions sometimes present. *Odour* not distinct in the dried specimen. *Spore deposit* white. *Basidiospores* 9.0–12.0 $\times$ 7.0–9.0 μm , subglobose to ellipsoid, hyaline, thin-walled, smooth. *Basidia* 42–65 $\times$ 7.0–18.0 μm , clavate, bearing four sterigmata, hyaline. Lamella-edge fertile. *Hymenophoral trama* regular, 40–130 μm wide, with hyaline hyphae, 5.0–7.0 μm diam. *Subhymenial layer* 8.0–19.0 μm wide, narrow, interwoven. *Pileipellis* a repent epicutis of narrow, radial hyphae with yellowish vacuolar pigment, 3.0–6.0 μm diam.

Specimens examined: **China**: Qinghai Province, Datong City, Dongxia, on soil in woods of *Picea* sp., 13 Aug. 1996, H. -A. Wen, Y. -C. Zong and X. -L. Mao, HMAS 63205. **England**: under *Fagus*, 10 Nov. 1953, L 0354464. **Finland**: Pohjois-Pohjanmaa: Kiiminki, calcareous area, Isohalmeenmaa, rich spruce forest, 12 Sept. 1974, E. Ohenoja, L 0354465. **Germany**: 26 Sept. 1980, P. B. Jansen No. 80-271, L 0354466. **Belgium**: 7 Sept. 1982, E. Bois LePozt No. 87-397, L 0354467.

The above description is solely based on the Chinese collection, HMAS 63205. The other specimens from Europe were examined for purposes of comparison.

Tricholoma sulphureum is readily recognized by its strong smell reminiscent of coal-gas when fresh (not noted in this study because only dried material was examined), sulphur yellow pileus and lamellae, spore size longer than 10 μm and hyphae with clamp-connexions. *Tricholoma bufonium* (Pers.) Gill. and *T. inamoenum* (Fr.) Gill., both producing spores of 10 μm or larger, are similar to *T. sulphureum* (Singer 1986, Bon 1984, 1987). However, they differ from *T. sulphureum* most notably in their vinaceous brown pileus or whitish to cream lamellae.

Tricholoma sulphureum was previously described from Xizang Autonomous Region in China by Mao et al. (1993) and was later recorded twice again by Mao (1998, 2000), but no specimen was cited in supporting those reports. The viscid pileus when wet and the striate surface of the stipe recorded by Mao (1998, 2000) and Mao et al. (1993) have not been mentioned by European authors and they were not observed on the specimens listed above. This species was also reported by the Comprehensive Scientific Expedition to the Tibetan Plateau (1996) with reference to two specimens, but a detailed description was lacking. Examination of the two cited specimens (Yunnan Province, Gaoligong Mount. Lvqibai, Alt. 2100m, on defoliation layer, 8 July 1978, M. Zang 4011 (HKAS); and Yunnan Province, Gaoligong Mount. facing to Bolajing, on soil in bamboo forest, 9 July 1978, M. Zang 4020 (HKAS)) by the present authors revealed that the spore size was 6.0–10.0 $\times$ 5.0–6.0 μm or 4.0–8.0 $\times$ 4.0–6.0 μm , which is smaller than that of European specimens and in published European descriptions (Bon 1984, 1987, Phillips, 1988). Furthermore, the hyphae of these two specimens have no clamp-connexions, which are prominent in the collections from Europe. These two specimens reported as *T. sulphureum* from China possess characters differing from the typical morphology of the species and possibly belong to *T. equestre* or allied species. The collection of *Tricholoma sulphureum* described above is therefore the first true record of the species from China.

Acknowledgements

The authors wish to thank Profs D. N. Pegler and G. I. Zervakis for serving as pre-submission reviewers and for their valuable comments and suggestions, to Dr P. Roberts for critical reading of the manuscript and to Dr Z.-L. Yang for his help on identification of the specimen of *Amanita* species. Thanks are also due to Mr. L.-S. Wang of Herbarium of Cryptogams, Kunming Institute of Botany, Academia Sinica, Prof. H. Knudsen of University of Copenhagen, Dr R. Fogel of University of Michigan and Dr P. Audiffred of National Herbarium of the Netherlands for loans of *Tricholoma* specimens. This project is supported by 'Research Project of Innovation Programme' (KSCX2-SW-101C) and the scheme of 'Introduction of Overseas Outstanding Talents' operated by the Chinese Academy of Sciences, a research grant (30470008) and 'National Science Fund for Distinguished Young Scholars' (30025002) from the National Natural Science Foundation of China, and the 'Programme for International Science and Technology Cooperation Project of P. R. China' (2001CB711103) from the Ministry of Science and Technology.

Literature cited

- Bon M. 1984. Les Tricholomes de France et d'Europe occidentale. Editions Lechevalier S.A.R.L., Paris. 324 pp.
- Bon M. 1987. The Mushrooms and Toadstools of Britain and North-western Europe. Hodder & Stoughton. 352 pp.
- Comprehensive Scientific Expedition to the Tibetan Plateau. 1996. Chinese Academy of Sciences. Fungi in Hengduan Mountain Region. Beijing: Science Press. 1–598. (in Chinese).
- Deng H, Yao Y-J, Pegler DN. 2004. An annotated checklist of *Tricholoma* from China. *Journal of Fungal Research* **2**: 1–18.
- Hall IR, Wang Y, Amicucci A. 2003. Cultivation of edible ectomycorrhizal mushrooms. *Trends in Biotechnology* **21**: 433–438.
- Hostford D, Pilz D, Molina R, Amaranthus M. 1997. Ecology and management of the commercially harvested American matsutake mushroom. 68 pp. General Technical Report PNW-GTR-412. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
- Kytövuori I. 1988 (1989). The *Tricholoma caligatum* group in Europe and North Africa. *Karstenia* **28**: 65–77.
- Lim SR, Fischer A, Berbee M, Berch SM. 2003. Is the booted *Tricholoma* in British Columbia really Japanese matsutake? *BC Journal of Ecosystems and Management* **3**: 1–7.
- Mao X-L. 1998. Economic Fungi in China. Beijing: Science Press. 762 pp. (in Chinese).
- Mao X-L. 2000. The Macrofungi in China. Zhengzhou: Henan Science and Technology Press. 719 pp. (in Chinese).
- Mao X-L, Jiang C-P, Ouzhuciwang. 1993. Economic Macrofungi of Tibet. Beijing: Beijing Science & Technology Press. 651 pp. (in Chinese).
- Murata H, Yamada A, Babasaki, K. 1999. Identification of repetitive sequences containing motifs of retrotransposons in the ectomycorrhizal basidiomycete *Tricholoma matsutake*. *Mycologia* **91**: 766–775.
- Perini C, Barluzzi C, Laganà A, Salerni E. 2004. Biodiversità nel Senese – flora macromicetica nel XX secolo. Accademia delle Scienze di Siena, Detta de' Fisiocritici. Siena.
- Phillips R. 1988. Mushrooms and other fungi of Great Britain and Europe. London: Pan Macmillan Ltd. 288 pp.
- Rawe RF. 1997. The commercial harvesting of wild edible mushrooms in the Pacific Northwest region of the United States. *Mycologist* **11**: 10–15.

- Redhead SA. 1984. Mycological observations 13–14: on *Hypsizygus* and *Tricholoma*. Transactions of the Mycological Society of Japan **25**: 1–9.
- Saitta A, Venturella G, Raimondo FM. 2003. The mycological flora of *Fagus sylvatica* woods from Sicily. *Flora Mediterranea* **13**: 5–203.
- Singer R. 1951. The *Agaricales* (Mushrooms) in modern taxonomy. *Lilloa* **22**: 1–832.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed. Koenigstein: Koeltz Scientific Books. 981 pp.
- Smith AH. 1979. The stirps *Caligata* of *Armillaria* in North America. *Sydowia Beiheft* **7**: 368–377.
- Wang Y, Hall IR, Evans LA. 1997. Ectomycorrhizal fungi with edible fruiting bodies 1. *Tricholoma matsutake* and related fungi. *Economic Botany* **51**: 311–327.
- Zang M. 1990. A taxonomic and geographic study on the Song Rong (matsutake) group and its allied species. *Acta Mycologica Sinica* **9**: 113–127. (in Chinese).
- Zeller SM, Togashi K. 1934. The American and Japanese matsu-takes. *Mycologia* **26**: 545–558.
- Zervakis G, Dimou D, Balis C. (1998). A check-list of the Greek macrofungi, including hosts and biogeographic distribution: I. Basidiomycotina. *Mycotaxon* **66**: 273–336.

Basidiomycetous pathogens on grapevine: a new species from Australia—*Fomitiporia australiensis*

MICHAEL FISCHER¹, JACQUELINE EDWARDS^{2,3},
JAMES H. CUNNINGTON³ & IAN G. PASCOE^{2,3}

¹*michael.fischer@wbi.bwl.de*

Weinbauinstitut Freiburg, Merzhauser Str. 119
D-79100 Freiburg, Germany

²*Cooperative Research Centre for Viticulture*

P.O. Box 154, Glen Osmond, South Australia 5064, Australia

³*Primary Industries Research Victoria – Knoxfield Centre, Dept. of Primary Industries
Private Bag 15, Ferntree Gully Delivery Centre, Victoria 3156, Australia*

Abstract—Phylogenetic species recognition allows identification of a new basidiomycetous species, *Fomitiporia australiensis*, associated with white heart rot of esca-affected grapevines in Australia. Microscopical characters of fruit bodies are very similar to those of the closely related species, *F. punctata* and *F. mediterranea*. *Fomitiporia australiensis* is distinct by forming both resupinate and pileate fruit bodies and by the sequences of the ribosomal ITS region. Fruit bodies of the species are rarely found in the field; existence as vegetative mycelium is prevailing. No definite statements are possible referring to exact geographic distribution and host range of the species.

Keywords—biodiversity, esca, *Hymenochaetales*, phylogeny, wood-inhabiting fungi

Introduction

Botanical evidence suggests that the species of grape most widely used for wine, *Vitis vinifera*, was originally domesticated in Caucasia and western Iran about 5000 years ago. Later on, wine grape cultivation spread into the eastern Mediterranean region and reached France, Spain, Portugal and Algeria about 500 B.C. In Australia, grape cuttings were brought in by the first settlers in 1788 and successfully established at the site of the present Sydney Royal Botanic Gardens (Gregory 1988).

Esca is a disease of grapevines that dates back to ancient Greece and Rome (Mugnai et al. 1999). The disease regained prominence in the late 19th and early 20th century; during that time, wine growing regions both in France (Ravaz 1898) and Italy (Petri 1912) suffered from losses caused by the disease. In the 1950s, black measles, an esca-related disease, was reported in California (Chiarappa 1959), and currently esca is causing major losses in the wine growing regions of Europe (Surico 2001). In Australia, however, although esca is present, it is not causing serious economic losses (Edwards & Pascoe 2004).

The external symptoms of esca include interveinal chlorosis and necrosis of foliage, black spotting and shriveling of berries, and sometimes rapid collapse (apoplexy) of the whole grapevine. There are two similar, possibly precursor, diseases of grapevine, namely Petri disease and young esca. Foliar and berry symptoms of the latter can be identical to those of esca. However, esca is distinguished by the presence of white heart rot found inside the trunk and/or main branches of affected grapevines (Surico, 2001). All three diseases are thought to be caused by a specific range of lignicolous ascomycete and/or basidiomycete fungi, and in the case of esca, these fungi usually occur together (Mugnai et al., 1999; Fischer & Kassemeyer, 2003). The fungi responsible for Petri disease have been identified as *Phaeomoniella chlamydospora* W. Gams, Crous, M.J. Wingf. & L. Mugnai (*Pch*; anamorphic member of the *Herpotrichiellaceae*; Crous & Gams, 2000) and/or *Phaeoacremonium aleophilum* W. Gams, Crous, M.J. Wingf. & L. Mugnai (*Pal*; anamorphic member of the *Magnaporthaceae*; Crous et al., 1996; Dupont et al., 1998, 2000). The teleomorphic state of *Pal* was only recently detected by research groups in Australia (Pascoe et al., 2004), South Africa (Mostert et al., 2003) and the USA (Rooney et al., 2002), and was identified as *Togninia minima* (Tul. & C. Tul.) Berl. (Calosphaerales; Hausner et al., 1992). While the spectrum of fungal organisms associated with Petri disease seems to be fairly uniform throughout wine growing regions, available evidence suggests the situation to be more complex for the esca-related white heart rot basidiomycetes (Fischer, 2000; Fischer, 2001).

With the data at hand, the recently described basidiomycete *Fomitiporia mediterranea* M. Fischer has to be seen as the main causal agent for the esca-associated white heart rot in Europe (Fischer, 2002; Fischer & Kassemeyer, 2003). *Trametes hirsuta* (Wulf. : Fr.) Pil. or *Stereum hirsutum* (Willd. : Fr.) Pers., fruit bodies of which are sometimes found on rotten wood of grapevine (Larignon & Dubos, 1997; Reisenzein et al., 2000), play a subordinate role only. Until recently, *F. mediterranea* in Europe has been misidentified as *F. punctata* (P. Karst.) Murrill, a closely related member of the Hymenochaetales widespread in the northern hemisphere (Gilbertson & Ryvarden, 1987; Ryvarden & Gilbertson, 1994; Cortesi et al., 2000). Identification problems also apply to wine growing regions of North America, where vegetative mycelia isolated from white heart rot of grapevine have been assigned to *Phellinus igniarius* (L.) Quél. (Chiarappa, 1997). This, however, is a European based species, almost exclusively occurring on species of *Salix* (Fischer, 1995; Fischer, 2000; Fischer & Binder, 2004).

In this way, conclusive data on grapevine-inhabiting basidiomycetes exist for Europe only; information is sparse or essentially non-existing for all other wine growing countries. A preliminary overview on the genetic varieties of basidiomycetes occurring on grapevine in South America and Australia has been provided by Fischer (2001). A more detailed study on the putative causal agent of „hoja de malvon“ in Argentina, a disease possibly identical with esca, was presented by Gatica et al. (2000). The exact identity of the particular fungus remains unclear, even though a classification within *Inonotus* s.l., a member of the Hymenochaetales, seems likely based on the available molecular data (Fischer, 2001; Gatica et al., 2004). In Australia, white heart rots similar to those associated with esca have been observed in grapevine, and fungi referable to the Hymenochaetales have been isolated (Edwards et al., 2001; Fischer, 2001). However, corresponding fruit bodies were detected very rarely and usually in such poor condition

that confident identifications could not be made.

Fruiting structures of esca-related basidiomycetes are hard to find or they may occur on non-*Vitis* hosts not well investigated so far. In general, existence of these fungi can only be demonstrated by the vegetative mycelia that are isolated from the infected wood. Several keys are available for identification of lignicolous fungi in pure culture (Nobles, 1965; Stalpers, 1978), but they are incomplete due to numerous taxonomic novelties and an accurate identification to species level is often not possible.

It is the goal of this study to characterize and, if possible, to identify a number of basidiomycetes of uncertain affinity derived from heart rotted wood of grapevine and, in one case, a species of *Dodonaea* (native hop-bush) in Australia. When available, fruit bodies were examined using morphological and microscopical characters. For all isolates, molecular sequences were generated for the nuclear encoded ribosomal ITS region. Using a phylogenetic approach, the obtained sequences were compared with selected representatives of the Hymenochaetales belonging to the putatively closely related genera *Phellinus*, *Inonotus*, *Inocutis*, *Mensularia* and *Fomitiporia*.

Specifically, the following questions were addressed in this study: (i) Can the isolates be assigned to basidiomycetes already known to occur on grapevine? (ii) Do they represent species known to occur in the southern hemisphere, but not known to be associated with esca-affected grapevine? Or (iii) do they represent taxa so far undescribed?

Materials and Methods

Fungal material and culturing — The strains used are listed in Table 1. Specimens are deposited at the University of Regensburg Herbarium (REG) in Germany and at the Victorian Plant Research Institute Herbarium (VPRI) in Australia. Mycelial cultures were grown on malt extract medium (ME; agar, 2%; malt extract, 2%; yeast extract, 0.05% in distilled water) under daylight conditions. For determination of temperature requirements all Australian isolates were incubated on ME at 15°C, 21°C, and 30°C. Mycelial growth was measured under 21°C and 30°C conditions by calculating the mean of two perpendicular colony diameters. Two repeats were performed for each isolate.

Comparative microscopy of fruit bodies — Sections of fruit bodies were placed on a slide in a drop of Melzer's reagent or lactophenol-cotton blue (Meixner, 1975); examinations were at 500x or 1250x under phase contrast optics. A maximum of twenty observations was recorded for measurements of basidiospores.

DNA isolation and PCR amplification — Whole cell DNA was isolated from cultured mycelium as described by Lee and Taylor (1990). Quantity and quality of the DNA were examined on 1% agarose gels. Isolated DNA was diluted 1:100 or 1:1000 in distilled water. The polymerase chain reaction (PCR) was used to amplify a portion of the nuclear encoded ribosomal DNA unit defined by the primer combination prITS5 and prITS4 (for primer sequences, see White et al., 1990). The fragment spans the entire ITS1 region, the 5.8S rRNA gene, and the ITS2 region. The PCR reactions were set up in 50 μ l volumes and were overlaid with two drops of mineral oil. Hot start

Table 1. List of fungal taxa and strains

Species (strain number, date, location, collector)	Substrate	GenBank no
<i>Phellinus igniarius</i> (L.) Quél.: 85-625 ¹ , 25.6.1985, Germany, MF ³ TN5758 ¹ , 25.5.1994, Finland, TN	<i>Salix caprea</i> L. <i>Salix</i> L.	AF515573 AF515574
<i>Fomitiporia robusta</i> (P. Karst.) Fiasson & Niemelä: 89-828 ¹ , 28.8.1989, Estonia, AB	<i>Quercus</i> L. <i>Fraxinus excelsior</i> L.	AF515565 AF515560
96-515 ¹ , 15.5.1996, Germany, LK	<i>Salix caprea</i>	AF515563
<i>Fomitiporia punctata</i> (P. Karst.) Murrill: 85-74 ¹ , 4.7.1985, Germany (Bavaria), MF	<i>Rhamnus cathartica</i> L.	AF515564
87-511 ¹ , 11.5.1987, Germany, WP	<i>Sorbus aucuparia</i> L.	AF515562
89-826b ¹ , 26.8.1989, Estonia, AB	<i>Sorbus aucuparia</i>	AF515561
Dai2727 ¹ , 5.10.1997, Finland, YCD		
<i>Fomitiporia mediterranea</i> M. Fischer: CA3 ² , VIII-1997, Italy (Tuscany), PC	<i>Vitis vinifera</i> (DC.) Beg.	AF515575
99-105 ¹ , 5.10.1999, Italy (Lazio), MF	<i>Corylus avellana</i> L.	AF515586
45/23 ¹ , VIII-2001, Germany, MF	<i>Vitis vinifera</i>	AF515585
<i>Fomitiporia australiensis</i> M. Fischer et al.: VPRI 22409b ¹ , 10.4.2000, South Australia, IP, JE & EC	<i>Dodonaea viscosa</i> (L.) Iacq.	AY624995
VPRI 22451 ² , 17.3. 2000, Australia (Victoria), IP & JE	<i>Vitis vinifera</i>	AY624996
VPRI 22485 ² , 21.2.2000, Australia (Victoria), IP & JE	<i>Vitis vinifera</i>	AY624987
VPRI 22486 ² , 17.3.2000, Australia (Victoria), IP & JE	<i>Vitis vinifera</i>	AY624988
VPRI 22859 ¹ , 19.2.2001, Australia (Victoria), IP, JE & NL	<i>Vitis vinifera</i>	AY624997
Unknown species: VPRI 22488 ² , 10.4.2000, South Australia, IP, JE & EC	<i>Vitis vinifera</i>	AY624989
VPRI 22492 ² , 10.4.2000, South Australia, IP, JE & EC	<i>Vitis vinifera</i>	AY624990
VPRI 22495 ² , 10.4.2000, South Australia, IP, JE & EC	<i>Vitis vinifera</i>	AY624991
<i>Inonotus hispidus</i> (Bull. : Fr.) P. Karst. 86-829 ¹ , 29.8.1989, Germany, MF	<i>Fraxinus excelsior</i> L.	AY624993
<i>Mensularia radiata</i> (Sow. : Fr.) W.B. Cooke: 85-107 ¹ , 7.10.1985, Germany, MF	<i>Alnus incana</i> (L.) Moench	AY624992
<i>Inocutis rheades</i> (Pers.) Fiasson & Niemelä: 86-922 ¹ , 22.9.1986, Germany, MF	<i>Populus tremula</i> L.	AY624994

¹ mycelium isolated from fruit bodies; ² mycelium isolated from infected wood (Fischer & Kassemeyer, 2003); ³ MF Michael Fischer, TN Tuomo Niemelä, AB Andreas Bresinsky, LK Lothar Kriegelstein, WP Wolfgang Paulus, YCD Yu-Cheng Dai, PC Paolo Cortesi, IP Ian Pascoe, JE Jacqueline Edwards, EC Eve Cottral, NL Natalie Laukart.

PCR was applied throughout (d'Aquila et al., 1991). Forty cycles were performed on a TRIO-Thermoblock (Biotra, Germany), using the following parameters: 95°C denaturation step (1 min), 50°C annealing step (1 min), 72°C primer extension (1 min). A final incubation step at 72°C (7 min) was added after the final cycle. 5 µl of each PCR reaction were electrophoresed on 1% agarose gels. A 100 bp DNA ladder (MBI Fermentas, Lithuania) was used as standard. The amplified products were purified with the QIAquick PCR Purification Kit (Qiagen, Germany) following the manufacturer's instructions. DNA was suspended in 20 - 50 µl Tris-HCl buffer (10 mM, pH 8.0).

Sequencing — All strains listed in Table 1 were included in the sequencing experiments. Instead of mycelium derived from fruit bodies and/or infected wood, single spore isolates were used for strains 45/23 and TN5758, designated 45/23.3 and TN5758.1, respectively. Fragments were sequenced with the AmpliTaq DNA Polymerase FS Dye Terminator Cycle Sequencing kit (Perkin Elmer, USA), using 2 µl of premix, 1 µl of the primers (8 pmol of prITS1 and prITS4, respectively), and 3.5 µl of the PCR products. The reactions were set up in 11 µl volumes, and were overlaid with one drop of mineral oil. Sequences were generated in two directions and twenty-five amplification cycles were carried out, using the following parameters: 96°C denaturation step (30 s), 59°C annealing step (15 s) for prITS1, 53°C annealing step (15 s) for prITS4, 60°C primer extension (4 min). DNA was precipitated by addition of 2 µl of NaAc (3 M, pH 4.8) and 55 µl of EtOH 100%, and was then washed with 150 µl of EtOH 70%. The DNA pellet was resuspended in 1 : 4 EDTA (50 mM, pH 8.0) : formamide. The electrophoresis was done with an ABI 373A Automatic Sequencer (Perkin Elmer).

Alignment and phylogenetic analyses — After processing the raw data with SeqEd (version 3.0), the sequences were aligned using the ClustalX (version 1.64b) program (Thompson et al., 1997). A final alignment was performed by eye. Alignment gaps were treated as missing data and all positions were included in the final alignment. The sequences obtained have been deposited in GenBank (for numbers, see Table 1), sequence alignments have been deposited in TreeBASE as submission no. SN 1893. For neighbor-joining analysis, a distance matrix was generated using DNA DIST, a program from the PHYLIP 3.5c package (Felsenstein, 1995) integrated in ClustalX. The calculation was performed using the Kimura 2 model and a transition:transversion ratio 2 : 1. Bootstrap values for internal nodes were calculated by 1000 replications (Felsenstein, 1985).

Results

Fruit body morphology and mycelial characters of Australian isolates — From eight Australian isolates examined, only two, 22409b (from *Dodonaea viscosa*) and 22859 (from *Vitis vinifera*), were associated with fruit bodies. These fruit bodies were of different shape, being pileate for 22409b, and resupinate for 22859. No clear differentiation was revealed by microscopical means. Basidiospores were slightly smaller in 22409b, with 6 x 5 µm on the average, while they were 7 x 5.5-6 µm in 22859; however, only few spores were found in 22409b.

In detail, morphological and microscopical features of fruit bodies were as follows:

Fruit bodies associated with white heart rot; perennial, variable in shape, resupinate or pileate, inseparable, woody hard; up to 8 mm thick; margin narrow, golden brown. Pore surface greyish brown to ferruginous; pores oblong ellipsoidal to circular, (2) 3-5 per mm, dissepiments thick, entire. Context darker than pore surface, brown to reddish brown, up to 2 mm thick; tubes concolorous with pore surface, up to 6 mm long. Hyphal system dimitic; septa without clamp connections; tissue darkening with KOH. Skeletal hyphae pale golden brown to ferruginous, rarely branched, thick-walled, 2-5 μ wide; generative hyphae hyaline, thin-walled, rarely branched, 2-3 μ wide. Setae absent. Spores ellipsoidal - subglobose, hyaline, thick-walled, smooth, dextrinoid and cyanophilous, (6) 7 (8) x (5) 5.5 - 6 (6.5) μ m.

While the fruit body of 22409b was distinct by its pileate shape, microscopical characters allowed no differentiation between Australian specimens and the European based species, *Fomitiporia punctata* and *F. mediterranea*.

Australian isolates were able to grow at all temperatures between 15°C and 30°C. Appearance of cultured mycelium was not uniform, and two main groups were distinguished. Strains 22488, 22492, and 22495 had fast growing mycelia, with 3.1 - 3.3 and 6.4 - 6.6 cm/wk under 21°C and 30°C conditions, respectively. In such cultures, pigmentation of the medium was weak or lacking; aerial hyphae were well developed, whitish, with yellowish rings or spots, preferably next to the inoculum; colonies became locally velvety and brownish after several weeks.

Strains 22451, 22485, 22486, and 22859 had slow growing mycelia, with 1.8 - 2.4 and 1.7 - 2.6 cm/wk under 21°C and 30°C conditions, respectively. Pigmentation of the medium was modest to strong; aerial hyphae were less developed, resulting in a more woolly appearance of the culture; yellowish to brownish colors were predominant, with whitish colors restricted to the margin of the growing culture.

22409b had even slower growth, with 0.8 and 1.1 cm/wk under 21°C and 30°C conditions, respectively; pigmentation of the medium was very strong (corresponding to the „staining type“ as described in Fischer, 1987); however, mycelial type of this culture could vary in subsequent inoculations, and then was similar to the group above.

Molecular sequences and phylogenetic analysis — Molecular sequences of the ribosomal ITS region were generated for all Australian isolates and the putatively related *Inonotus hispidus*, *Inocutis rheades*, and *Mensularia radiata* (Edwards et al., 2001; Fischer, 2001). Corresponding sequences of *Phellinus igniarius*, *Fomitiporia robusta*, *F. punctata*, and *F. mediterranea* were derived from a former study (Fischer, 2002).

For 86-829 (*Inonotus hispidus*) and 22492 (Australian isolate from *Vitis vinifera*), sequences were incomplete at the 5' end. As a consequence, this particular section, comprising approximately 35 nucleotides of the ITS1 region, was omitted for all strains in the final alignment. The aligned data set included 805 positions. Sizes of the DNA region were as follows:

Phellinus igniarius: 606 - 610 nucleotides, *Inonotus hispidus*: 708 nucleotides, *Inocutis rheades*: 668 nucleotides, *Mensularia radiata*: 634 nucleotides, *Fomitiporia robusta*:

689 - 690 nucleotides, *F. punctata*: 684 - 685 nucleotides, and *F. mediterranea*: 706 - 709 nucleotides.

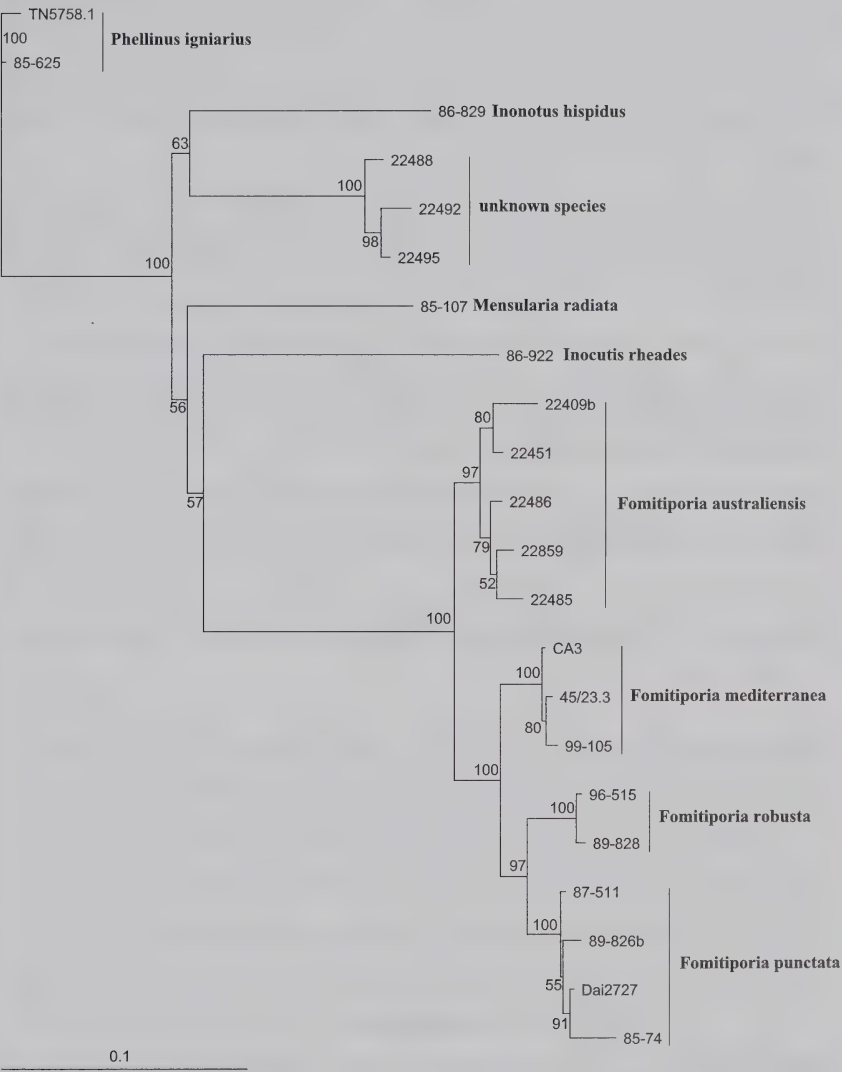


Figure 1: Phylogenetic relationships of *Fomitiporia australiensis* and related Hymenochaetales taxa inferred from the nuclear ITS1-5.8S-ITS2 region using the neighbor-joining method. The tree was rooted with isolates belonging to *Phellinus igniarius*. Bootstrap values of 50% or greater are indicated for the corresponding nodes. The scale bar represents 0.01 substitutions per site. The proposed specific designation is explained in the text.

The Australian isolates fell into two groups: strains 22451, 22485, 22486, and 22859 were 634-638 nucleotides, while strains 22409b, 22488, 22492, and 22495 were 686-692 nucleotides. As a striking phenomenon, sequences of strain 22409b were widely identical with those of the former group, but were separated by three inserts all existing within the ITS1 region.

A phylogenetic analysis using the neighbor-joining method resulted in a subdivision of the Australian isolates into two distinct groups; these were not assignable to any of the other taxa included as references (Fig. 1).

The larger group, comprising 5 strains, formed a strongly supported (100%) cluster together with the taxa belonging to the genus *Fomitiporia*, i.e. *F. mediterranea*, *F. robusta*, and *F. punctata*. Both fruit body forming strains, 22409b (pileate) and 22859 (resupinate), are enclosed in this group. As mentioned above, 22409b is characterized by a divergent size of the PCR product, and this is reflected in a peripheral position within the cluster. Together with another strain (22451), 22409b forms a separate subgroup.

The smaller group of Australian strains, comprising three mycelial isolates (22488, 22492, and 22495), came out as related to *Inonotus hispidus*, although only modestly supported by a bootstrap value of 63% (Fig. 1).

Taxonomic conclusions — Molecular data show the Australian isolates to be genetically distinct. One of the revealed groups, including strains 22451, 22485, 22486, 22859 (from *Vitis*), and 22409b (from *Dodonaea*) shows a clear affinity to *Fomitiporia*, but is not assignable to any of the included taxa of this genus (see discussion below for further comments). Accepting the molecular data as distinct characters (phylogenetic species recognition; Taylor et al., 2000; Fischer & Binder, 2004), we suggest a specific taxonomic status for these isolates:

***Fomitiporia australiensis* M. Fisch., J. Edwards, Cunningham & Pascoe, sp. nov.**

Basidiomata perrenia, resupinata ad ungulata; superficies pororum brunnea, pori ellipsoideae ad circulares, 2-5 in quoque millimetro; systema hypharum dimiticum, omnia septa fibulis egentia; hyphae skeletales luteobrunneae, 2-5 µm latae, hyphae generativae hyalinae, 2-3 µm latae; sporae ellipsoideae ad subglobosae, hyalinae, crassitunicatae, cyanophilicae et amyloideae, 6-8 x 5-6.5 µm.

Holotypus 22859 in Victorian Plant Disease Herbarium (VPRI), collectus a I. Pascoe, J. Edwards, N. Laukart, in *Vitis vinifera* in Australia, 2001.

Discussion

Within *Fomitiporia*, several so-called sibling species (Petersen & Hughes 1999) exist which are not distinguishable by traditional characters such as morphology of fruit bodies (morphological species recognition; for modes of species recognition, see Taylor et al., 2000), but are separable by molecular data (phylogenetic species recognition) and, if applicable, pairing tests of single spore testers (biological species recognition). Such closely related taxa are *F. punctata*, *F. mediterranea* (Fischer 2002), and, now,

F. australiensis sp. nov. One more species, hardly separable from the above taxa by traditional means, exists on hardwood in North America, but is not included here (Fischer & Binder, 2004).

In Cunningham's study on polypores of New Zealand and Australia (Cunningham, 1965) one taxon, designated *Fuscoporia punctata* (Fries) G.H. Cunningham, appears to be morphologically close to *F. australiensis*, and one could speculate that some of the material currently considered to be *Fuscoporia punctata* is, in fact, *F. australiensis*. The fruit bodies of *Fuscoporia punctata* are described as effused-reflexed by Cunningham, while they are strictly resupinate in *Fomitiporia punctata* and *F. mediterranea*, and both resupinate and pileate in *F. australiensis*. As another distinct character, species of *Fomitiporia* have dextrinoid and cyanophilous basidiospores, while this is not mentioned for *Fuscoporia punctata* (Cunningham, 1965). In addition, neither *Vitis* nor *Dodonaea* are among the listed host plants of this species.

At the present time, *Fomitiporia* comprises approximately one dozen species worldwide (Gilbertson & Ryvarden, 1987; Ryvarden & Gilbertson, 1994; Fischer, 2002; Fischer & Binder, 2004). Two of these, *F. mediterranea* in Europe and *F. australiensis* in Australia, are associated with white heart rot in esca-affected grapevine. With these data available, *Fomitiporia* represents the economically most important basidiomycetous group related to esca disease. Some other genera of basidiomycetes, such as *Trametes* or *Stereum*, have been mentioned as occurring on diseased *Vitis vinifera*, but they are mostly associated with dead wood and therefore play a subordinate role only (Jahn, 1963; Fischer & Kassemeyer, 2003).

It remains an open question why fruit bodies of *F. australiensis* are rarely found and its presence in an infected host is only detected as vegetative mycelium. Possibly the formation of fruit bodies is correlated with the age and/or overall condition of the host plant, and dead trunks of grapevine most suitable for bearing fruit bodies have usually been removed from the vineyard. We do not know if a higher number of fruit bodies can be found on non-*Vitis* host plants outside of vineyards in Australia, but in Italy it has been demonstrated that *F. mediterranea* fruit bodies are rarely found within vineyards (Cortesi et al., 2000), yet seem to exist in considerable numbers on hosts outside of vineyards (Fischer, 2002). In vineyards examined in Central Europe, fruit bodies of *F. mediterranea* were only present on 1-3% of esca-affected grapevines older than 15 years, although often more than 50% of the trunks had symptoms of white heart rot (Fischer, unpubl. results). Evidently, grapevines may be affected with white heart rot without showing external symptoms on leaves or berries and they may host the inconspicuous fungus for many years. In view of this, the distribution of fruit bodies is unlikely to be truly indicative of the frequency of basidiomycetes associated with esca.

It is generally accepted that many lignicolous fungi are widely restricted to an existence as a vegetative mycelium. A sparse development of fruit bodies in the field and, therefore, a modest number of airborne basidiospores functioning as distribution units may be sufficient to infect a considerable number of suitable host plants (Edman & Gustafsson, 2003). Since fruit body development is affected by numerous environmental factors, the biodiversity and occurrence of lignicolous fungi is more properly estimated on the basis of vegetative mycelia, preferably using a molecular approach (Fischer & Wagner,

1999; Vainio & Hantula, 2000). Future research on a wide range of host plants will provide new insights into biogeographical distribution patterns of fungi, and is likely to lead to the detection of rare or even new taxa.

In this study we have demonstrated the existence of a new basidiomycetous species on grapevine; with the data at hand this species can be demonstrated only by sequence data of the ribosomal ITS region. Specific primers could prove useful for more rapid identification of vegetative mycelia of *F. australiensis*, and appropriate studies are presently underway. Another taxon, as-yet-undetermined, was detected in this study, with distinct molecular sequences and growth behavior of cultured mycelium. Based on the sequences available, it was revealed as possibly related to *Inonotus hispidus*, an important pathogen on fruit and nut trees in Europe (Ryvarden & Gilbertson, 1994) and North America (Adaskaveg & Ogawa, 1990). Further studies are in progress to clarify the accurate taxonomic state of the isolates 22488, 22492 and 22495.

Acknowledgements

This study was financially supported in part by the Commonwealth Cooperative Research Centres Program of Australia and conducted by the CRC for Viticulture with support from Australia's grapegrowers and winemakers through their investment body, the Grape and Wine Research and Development Corporation, with matching funds from the Australian Government, and in part by the Bundesanstalt für Landwirtschaft und Ernährung, BLE, Germany. We thank Mrs Natalie Laukart and Mrs Soheir Salib for valuable technical assistance.

Literature cited

- Adaskaveg JE, Ogawa JM. 1990. Wood decay pathology of fruit and nut trees in California. *Plant Disease* 74: 341-352.
- Chiarappa L. 1959. Extracellular oxidative enzymes of wood-inhabiting fungi associated with the heart rot of living grapevines. *Phytopathology* 49: 578-582.
- Chiarappa L. 1997. *Phellinus igniarius*: the cause of spongy decay of black measles („esca“) disease of grapevines. *Phytopathologia Mediterranea* 36: 109-111.
- Crous PW, Gams W, Wingfield MJ, van Wyk PS. 1996. *Phaeoacremonium* gen. nov. associated with wilt and decline diseases of woody hosts and human infections. *Mycologia* 88: 786-796.
- Crous PW, Gams W. 2000. *Phaeomoniella chlamydospora* gen. et comb. nov., a causal organism of Petri grapevine decline and esca. *Phytopathologia Mediterranea* 39: 112-118.
- Cortesi P, Fischer M, Milgroom MG. 2000. Identification and spread of *Fomitiporia punctata* associated with wood decay of grapevine showing symptoms of esca disease. *Phytopathology* 90: 967-972.
- Cunningham GH. 1965. Polyporaceae of New Zealand. New Zealand Department of Scientific and Industrial Research 64: 1-304.
- D'Aquila RT, Bechtel LJ, Videler JA, Eron JE, Gorczyca P, Kaplan JC. 1991. Maximizing sensitivity and specificity of PCR by preamplification heating. *Nucleic Acids Research* 19: 3749.
- Dupont J, Laloui W, Roquebert MF. 1998. Partial ribosomal DNA sequences show an important divergence between *Phaeoacremonium* species isolated from *Vitis vinifera*. *Mycological Research* 102: 631-637.
- Dupont J, Magnin S, Parronaud J, Roquebert MF. 2000. The genus *Phaeoacremonium* from a molecular point of view. *Phytopathologia Mediterranea* 39: 119-124.

- Edman M, Gustafsson M. 2003. Wood-disk traps provide a robust method for studying spore dispersal of wood-decaying basidiomycetes. *Mycologia* 95: 553-556.
- Edwards J, Pascoe IG. 2004. Occurrence of *Phaeomoniella chlamydospora* and *Phaeoacremonium aleophilum* associated with Petri disease and esca in Australian grapevines. *Australasian Plant Pathology* 33: 273-279.
- Edwards J, Pascoe I, Laukart N, Cunningham J, Fischer M. 2001. Basidiomycetes isolated from esca-like heart rots of grapevines in Australia. *Phytopathologia Mediterranea* 40: S480-481.
- Felsenstein J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783-791.
- Felsenstein J. 1995. PHYLIP (Phylogeny Inference Package) version 3.5c, distributed by the author. Department of Genetics, University of Washington, Seattle.
- Fischer M. 1987. Biosystematische Untersuchungen an den Porlingsgattungen *Phellinus* Qué. und *Inonotus* Karst. *Bibliotheca Mycologica* 107: 1-139.
- Fischer M. 1995. *Phellinus ignarius* and its closest relatives in Europe. *Mycological Research* 99: 735-744.
- Fischer M. 2000. Grapevine wood decay and lignicolous basidiomycetes. *Phytopathologia Mediterranea* 39: 100-106.
- Fischer M. 2001. Diversity of basidiomycetous fungi associated with esca diseased vines. *Phytopathologia Mediterranea* 40: S480.
- Fischer M. 2002. A new wood-decaying basidiomycete species associated with esca of grapevine: *Fomitiporia mediterranea* (Hymenochaetales). *Mycological Progress* 1: 315-324.
- Fischer M, Binder M. 2004. Species recognition, geographic distribution and host-pathogen relationships: a case study in a group of lignicolous basidiomycetes, *Phellinus* s.l. *Mycologia* 96: 798-810.
- Fischer M, Kassemeyer H-H. 2003. Fungi associated with esca disease of grapevine in Germany. *Vitis* 42: 109-116.
- Fischer M, Wagner T. 1999. RFLP analysis as a tool for identification of lignicolous basidiomycetes: European polypores. *European Journal of Forest Pathology* 29: 295-304.
- Gatica M, Dubos B, Larignon P. 2000. The „hoja de malvon“ grape disease in Argentina. *Phytopathologia Mediterranea* 39: 41-45.
- Gatica M, Césari C, Escoriaza G. 2004. *Phellinus* species inducing hoja de malvón symptoms on leaves and wood decay in mature field-grown grapevines. *Phytopathologia Mediterranea* 43: 59-65.
- Gilbertson RL, Ryvarden L. 1987. North American Polypores, vol. 2. Fungiflora, Oslo, Norway.
- Gregory GR. 1988. Development and status of Australian viticulture. In: Coombe BG, Dry PR, eds. Viticulture Volume 1: Resources. Winetitles, Adelaide. p. 1-36.
- Hausner G, Eyjolfsson G, Reid J, Klassen GR. 1992. Two additional species of the genus *Togninia*. *Canadian Journal of Botany* 70: 724-734.
- Jahn H. 1963. Mitteleuropäische Porlinge (Polyporaceae s. lato) und ihr Vorkommen in Westfalen. *Westfälische Pilzbriefe* 4: 1-143.
- Larignon P, Dubos B. 1997. Fungi associated with esca disease in grapevine. *European Journal of Plant Pathology* 103: 147-157.
- Lee SB, Taylor JW. 1990. Isolation of DNA from fungal mycelia and single cells. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. PCR protocols. Academic Press, San Diego, USA. p. 282-287.
- Meixner A. 1975. Chemische Farbreaktionen von Pilzen. J. Cramer, Vaduz, Liechtenstein.
- Mostert L, Crous PW, Groenewald JZ, Gams W, Summerbell RC. 2003. *Togninia* (Calosphaerales) is confirmed as teleomorph of *Phaeoacremonium* by means of morphology, sexual compatibility and DNA phylogeny. *Mycologia* 95: 646-659.

- Mugnai L, Graniti A, Surico G. 1999. Esca (Black Measles) and Brown Wood-Streaking: Two old and elusive diseases of grapevines. *Plant Disease* 83: 404-418.
- Nobles MK. 1965. Identification of cultures of wood-inhabiting hymenomycetes. *Canadian Journal of Botany* 43: 1097-1139.
- Pascoe IG, Edwards J, Cunningham JH, Cottral EH. 2004. Detection of the *Togninia* teleomorph of *Phaeoacremonium aleophilum* in Australia. *Phytopathologia Mediterranea* 43: 51-58.
- Petersen RH, Hughes KW. 1999. Species and speciation in mushrooms. *BioScience* 49: 440-452.
- Petri L. 1912: Osservazioni sopra le alterazioni del legno della vite in seguito a ferite. *Le Stazioni Sperimentali Agrarie Italiane* 45: 501-547.
- Ravaz L. 1898: Sur le folletage. *Revue Viticulture* 10: 184-186.
- Rooney SN, Eskalen A, Gubler WD. 2002. First report of the teleomorph of *Phaeoacremonium* spp., the cause of esca and decline of grapevines. *Phytopathology News* 36: 116.
- Reisenzein H, Berger N, Nieder G. 2000 Esca in Austria. *Phytopathologia Mediterranea* 39: 26-34.
- Ryvarden L, Gilbertson RL. 1994. *European Polypores*, vol. 2. Fungiflora, Oslo, Norway.
- Stalpers JA. 1978. Identification of wood-inhabiting Aphyllophorales in pure cultures. *Studies in Mycology* 16: 1-248.
- Surico G. 2001. Towards commonly agreed answers to some basic questions on esca. *Phytopathologia Mediterranea* 40: S487-490.
- Taylor JW, Jacobson DJ, Kroken S, Kasuga T, Geiser DM, Hibbett DS, Fisher MC. 2000. Phylogenetic species recognition and species concepts in fungi. *Fungal Genetics and Biology* 31: 21-32.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 24: 4876-4882.
- Vainio EJ, Hantula J. 2000. Direct analysis of wood-inhabiting fungi using denaturing gradient gel electrophoresis of amplified ribosomal DNA. *Mycological Research* 104: 927-936.
- White TJ, Bruns TD, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. *PCR protocols*. Academic Press, San Diego, USA. p. 315-322.

Morphology and species identification of a *Hypocrella* species (GenBank accession # U47832)

AMANJEET K BATH¹, MONICA S. TORRES¹,
GARY J. SAMUELS² & JAMES F. WHITE, JR.^{1*}

Jwhite@aesop.rutgers.edu

¹Department of Plant Biology and Pathology, Cook College
Rutgers University, New Brunswick, NJ, USA

²USDA-ARS Systematic Botany & Mycology Laboratory
Room 304, B-011A, Beltsville, MD 20705-2350 USA

Abstract - GenBank accession U47832, *Hypocrella* sp., has been used in numerous phylogenetic studies involving ascomycetes but has not been identified to species previously. We have examined the specimen from which the sequence was obtained and have identified it as *Hypocrella nectrioides* (Ascomycetes, *Hypocreales*, *Clavicipitaceae*). It is one of only two species of *Hypocrella* for which sequences are deposited in GenBank. Except for a brief description by Petch (1921) structural features of *H. nectrioides* have not been previously published. We document the morphology of the teleomorph and anamorph of this poorly known species.

Key words- Ascomycetes, taxonomy, systematics

Introduction

Genus *Hypocrella* (*Clavicipitaceae* *Hypocreales*) was erected by Saccardo (1878) to accommodate four species previously assigned to *Hypocrea* Fr. (*Hypocreales*). Only one of the species remains in the entomopathogenic genus *Hypocrella* as recognized by Petch (1921) and Mains (1959). *Hypocrella* is one of the most readily recognized ascomycete genera because of its brightly colored stromata that form on scale insects, typically on living or fallen plant leaves. Worldwide more than 30 species of this pan tropical and subtropical genus have been described (Petch 1921; Hywel-Jones & Evans 1993; Tzean et al. 1997; Hywel-Jones & Samuels 1998; Liu et al. 2001).

Modern revisionary studies of *Hypocrella* and related genera are at an early stage (Hodge 2003). One specimen, (GenBank accession U47832) identified as *Hypocrella* sp., has been included in phylogenetic studies (e.g. Spatafora & Blackwell 1993; Suh et al. 1998; and Artjariyasripong et al. 2001) but the collection has never been identified to species. The specimen from which the sequence was derived is *Samuels 6609* (culture G.J.S. 89-104; NY), which was collected in Guyana in 1989. In the present study this specimen is identified as *Hypocrella nectrioides* Thaxt. Although the culture is no longer viable, the anamorphic stage on the dry culture included with the specimen,

was examined. An anamorph of *H. nectrioides* has not been reported previously, and *H. nectrioides* has never been described in modern terms. Both morphs of this species are described here.

Materials and Methods

Herbarium collections (dry stromata and conidiomata in dried culture) *Samuels 6609* (culture G.J.S. 89-104) were obtained from The New York Botanical Garden (NY). The pure culture was originally isolated from the specimen in 1989 from four single ascospores that were put on cornmeal dextrose agar (CM + 2% dextrose) and incubated at 20–21°C. The resulting culture was a composite of all four single ascospore cultures. The dry culture with the anamorph was deposited with the collection of the *Hypocrella* in NY.

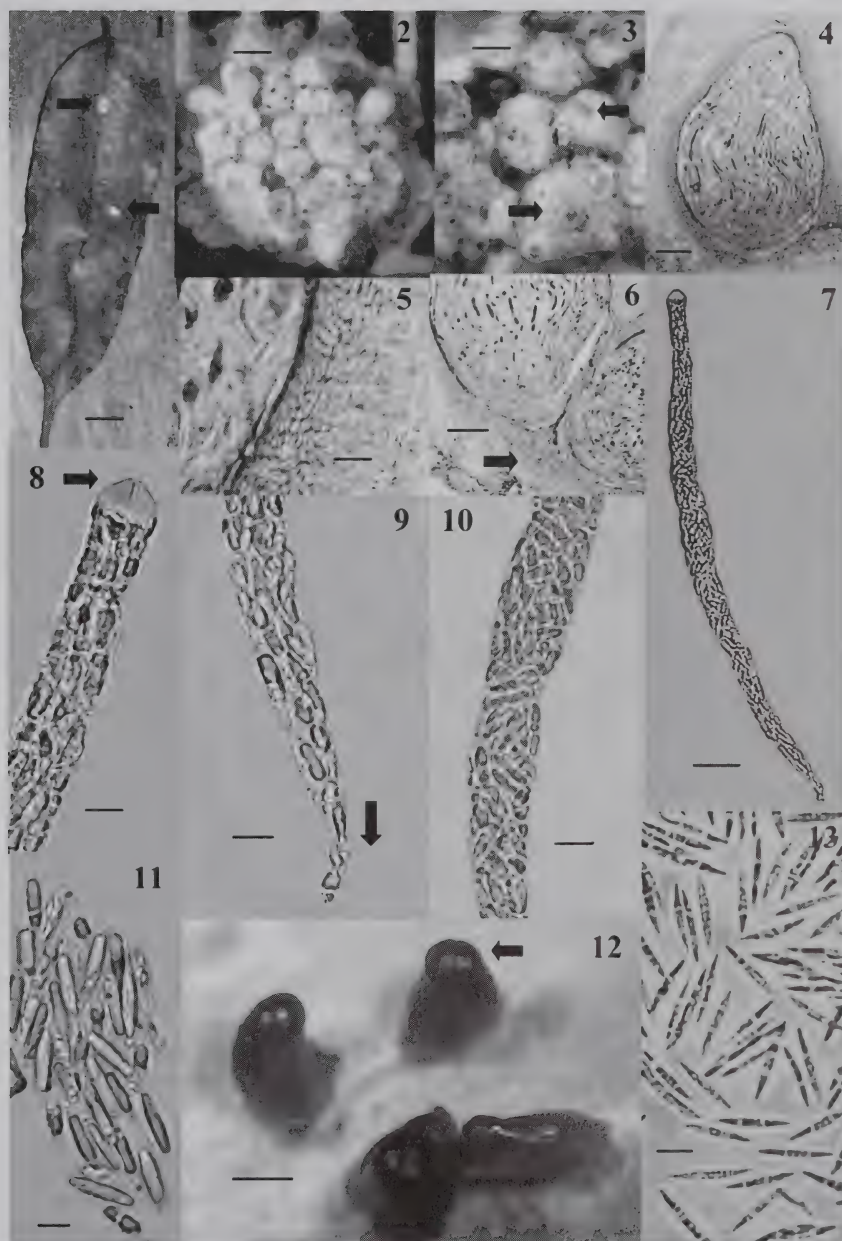
Dry stromata were fixed in FAA (five parts 37% formalin + five parts glacial acetic acid + 90 parts 50% ethanol) for a period of 24 hours, dehydrated in a graded ethanol series and embedded in L. R. White® embedding medium. Sections approximately 1.0 μm thick were obtained using glass knives and stained on a slide warmer for 30 sec. in aniline blue (0.1% aqueous) followed by toluidine blue (0.1% aqueous). The part-ascospores and conidia were examined by mounting and teasing out the contents of the perithecia and the conidiomata, respectively, in a droplet of 10% KOH. All measurements of structures were made using a compound microscope with a calibrated reticle. Microscopic details were photographed under a compound microscope using a digital camera (Nikon Coolpix 4300).

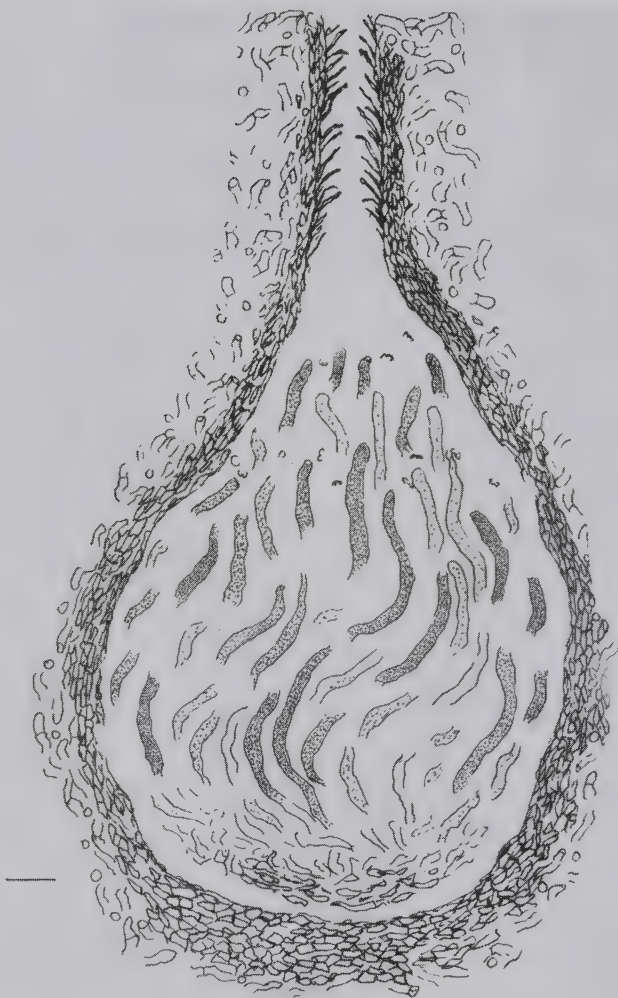
Taxonomy

Hypocrella nectrioides Thaxt.in Petch Ann. Roy. Bot. Gard. (Peradeniya) 7: 225 (1921). (Figs.1-14)

Stromata almost circular in outline, pulvinate, tuberculate; consisting of a dense mycelial mat surrounded by a membranous hypothallus, pale to pale white (in dry specimens); 2-3 mm in diameter; covered with several (up to 32) ovoid to clavate, erect tubercles (Fig.2). Internal tissue of the stroma consists of interwoven branched septate hyphae measuring up to 5 μm in diameter. Individual tubercle 0.5-0.8 mm in height and approximately 0.2-0.5 mm in width; surface tomentose, concolorous with stroma; each tubercle with 1-4 ostioles (mostly one) (Fig.3), ostiolar openings minute, dark, pale brown. Perithecia completely immersed in tubercles, with mostly single perithecia in

Hypocrella nectrioides. Figs.1-13. 1. Ascostromata (arrows) on scale insect on dicot leaf (bar=10mm) 2. Ascostroma showing membranous hypothallus and aggregated erect tubercles (bar=0.5mm) 3. Ascostromata showing tubercles with one ostiole and another with four ostioles (arrows) (bar=0.25 μm) 4. Vertical section of perithecium (bar=50 μm) 5. Detail of perithecial wall (bar=25 μm) 6.) Two perithecia arising from single base (arrow) (bar=60 μm) 7. Ascus containing spirally arranged part-ascospores (bar=25 μm) 8. Upper part of ascus showing thick ascus cap (arrow) (bar=5 μm) 9. Tapering (arrow) base of ascus (bar=5 μm) 10. Part-ascospores in central part of ascus (bar=5 μm) 11. Part-ascospores (bar=5 μm) 12. Conidial masses in dry culture showing subcapitate apex (arrow) (bar=0.5mm) 13. Fusoid conidia (bar=10 μm)





Hypocrella nectrioides Fig.14. Diagram of vertical section of perithecium showing periphysate ostiolar canal, asci arising from base and perithecial wall (bar = 25 μ m).

the tubercle, some tubercles fused together appearing to have 3-4 ostiolar openings in a single large tubercle (Fig.3); in fused tubercles perithecia often fused at base (Fig.6). Perithecia flask shaped (Fig.14), 380-420 x 250-280 μ m; perithecial wall 30-50 μ m thick (Fig.5), consisting of several layers of pseudoparenchymatous cellular elements (3-5 μ m broad); asci arising from the base of perithecia; perithecial neck periphysate,

140-175 μm long, opening non-emergent, up to 50 μm broad. Asci 250-305 x 10-12.5 μm (280 x 11 μm) in size, cylindrical; ascus tip thickened, refractive, hyaline, 10 μm wide, 7.5 μm deep, with a prominent central canal (Fig.8); each ascus containing 8 ascospores. Ascospores filiform, multi-transversely septate, arranged parallel in the upper part and in a loose spiral below (Figs.7-10), disarticulating into part-ascospores; part-ascospores measuring 8-14 x 2-3 μm (12 x 2.5 μm), cylindrical with truncate to obtuse ends, hyaline with few guttules (Fig.11).

Anamorph in culture evident as brightly orange colored, tuberculate to flattened conidial masses with subcapitate apices (Fig.12), containing compactly arranged numerous conidia. Conidia 12-22 x 2.5-3.5 μm (average size 15 x 3 μm), single celled, fusiform with tapering acute ends, hyaline when observed in 10% KOH, with several guttules (Fig.13).

Habit: On scale insects on living leaves of an unidentified dicotyledonous plant.

Specimen examined: GUYANA. Mt. Wokomung; Wokomung base camp, wet forest dominated by *Euphorbiaceae*; (1070m), 17 July 1989, *GJ Samuels, BM Boom, G Bacchus 6609* (NY, culture GJS 89-104).

Remarks

This specimen coincided well with the morphological features indicated by Petch (1921) for *Hypocrella nectrioides*. It is also similar to *Hypocrella raciborskii* as described by Tzean et al. (1997), including tuberculate ascostromata and shape and size of asci, but differs from that species by its slightly smaller, aseptate part-ascospores (8-4 x 2-3 μm) as compared to *H. raciborskii* (where part-ascospores are aseptate to septate and measure 8.7-19.1 x 2.8-4.0 μm). Moreover Petch (1921) distinguished the later species from *H. nectrioides* because tubercles formed at the margins of stromata in *H. raciborskii* and in the center of stromata in *H. nectrioides*. According to Petch (1921) the ascostroma of *H. nectrioides* is rosy orange in fresh material (white, slightly translucent in dry material) while in *Hypocrella raciborskii* ascostromata are always yellowish white. The color of *Samuels 6609* (dry herbarium specimen) is pale white and slightly translucent with darker ostiolar openings (the color of the fresh material is unknown). The conidial masses in culture were rosy orange in color. *Hypocrella nectrioides* is also similar to *H. amomi* Rac. but differs mainly in the shape of the part-ascospores, which are cylindric with obtuse to blunt ends in the former while fusoid with tapering ends in the later.

Hypocrella nectrioides was briefly described by Petch (1921) based on the study of the specimen collected by R. Thaxter from Trinidad on scale insects parasitizing leaves of a *Pentaclethra* sp. The collection location of *Samuels 6609*, Guyana, is geographically close to the type locality. While the specimens of *Hypocrella raciborskii* are reported from Southeast Asia (Taiwan, China, India, Sri Lanka and Java) (Petch 1921).

There has been no previous report of an anamorph of *H. nectrioides*. The mature stromata, evident in the herbarium material, showed no evidence of an anamorph. However, in the dried culture deposited with stromata in the herbarium packet the characteristic anamorph was evident. Its features were compared to the anamorph of *Hypocrella raciborskii*. We found that the conidia of the present specimen are comparatively larger (12-22 x 2.5-3.5 μm) than those of *Hypocrella raciborskii* (10-14 x 1.5-2 μm) (Petch 1921).

Discussion

The rDNA sequence of this specimen (GenBank accession U47832) is one of only two species of *Hypocrella* where sequence data is available for molecular phylogenetic studies (Spatafora & Blackwell 1993; Suh et al. 1998; and Artjariyasriping et al. 2001), hence it is important to confirm the generic and species identity of the collection and to document its morphology and anatomy. In identifying this specimen and documenting its phenotypic features, it is our intention to fill in a data gap regarding the genus *Hypocrella*. Having a more complete data set for *Hypocrella nectrioides* that includes morphology as well as sequence data will facilitate ongoing systematic work in the *Clavicipitiaceae* (Hywel-Jones & Evans 1993; Hodge & Krasnoff 1995; Spatafora & Blackwell 1993; Tzean et al. 1997; Hywel-Jones & Samuels 1998; Liu et al. 2001; Suh et al. 1998; Spatafora et al. 2000; Artjariyasriping et al. 2001; and Hodge 2003).

Acknowledgements

This research was supported in part by National Science Foundation Grant BSR 8721877 to G.J.S. and The New York Botanical Garden. We are grateful to Drs. Gerald Bills and Richard Humber for review versions of the manuscript. Ms Miao Liu and Dr. N.L. Hywel-Jones provided helpful comments for the manuscript.

References

- Artjariyasriping S, Mitchell JJ, Hywel-Jones NL, Jones EBG. 2001. Relationship of the genus *Cordyceps* and related genera, based on parsimony and spectral analysis of partial 18S and 28S ribosomal gene sequences. *Mycoscience* 42: 503-517.
- Hodge KT, Krasnoff SB. 1995. *Tolypocladium niveum*, anamorph of *Cordyceps facis*. *Inoculum* 46: 19.
- Hodge KT. 2003. Clavicipitaceous anamorphs. Pp. 75-123. *In* Clavicipitacean Fungi. Evolutionary Biology, Chemistry, Biocontrol, and Cultural Impacts (eds White, J.F., Jr., Bacon, C.W., Hywel-Jones, N.L. and Spatafora, J.W.). Marcel-Dekker, New York, Basel, USA.
- Hywel-Jones NL, Evans HC. 1993. Taxonomy and ecology of *Hypocrella discoides* and its anamorph, *Aschersonia samoensis*. *Mycol. Res.* 97(7): 871-876.
- Hywel-Jones NL, Samuels GJ. 1998. Three species of *Hypocrella* with large stromata pathogenic on scale insects. *Mycologia* 90(1): 36-46.
- Liu P, Wang X, Li Z, Yang Z, Zhang D. 2001. Notes on the bambusicolous species of the genus *Hypocrella* from Southwestern China. *Mycotaxon*. 78: 67-74.
- Mains EB. 1959. Species of *Hypocrella*. *Mycopathol. Mycol. Appl.* 11: 311-326.
- Petch T. 1921. Studies in entomogenous fungi. II. The genera *Hypocrella* and *Aschersonia*. *Ann. Roy. Bot. Gard. (Peradeniya)* 7: 167-278.
- Saccardo PA. 1878. Enumeratio pyrenomycetum hypocreaceorum. *Michelia* 1:277-325.
- Spatafora JW, Blackwell M. 1993. Molecular systematics of unitunicate perithecial ascomycetes: The *Clavicipitales-Hypocreales* connection. *Mycologia* 85(6): 912-922.
- Spatafora JW, Sung GH, Davies K, Hodge KT. 2000. Systematics of *Cordyceps* and evolution of host shifts. *Mycology 2000. British Mycological Society Meeting in Liverpool, April 2000*, p.20.
- Suh S, Spatafora JW, Ochiol GRS, Blackwell M. 1998. Molecular phylogenetic study of a termite pathogen *Cordycepioides bisporus*. *Mycologia* 90(4): 611-617.
- Tzean SS, Hsieh LS, Wu WJ. 1997. Atlas of entomopathogenic fungi from Taiwan. Council of Agriculture, Executive Yuan Taiwan, R.O.C.: 70-71.

Contribution to the lignocellulolytic fungi (Basidiomycetes) of the Atlantic Rain Forest in Southern Brazil

CLAUDIA GROPOSO

calitagr@hotmail.com

&

CLARICE LOGUERCIO-LEITE

*Laboratório de Micologia, Departamento de Botânica
Universidade Federal de Santa Catarina, Florianópolis,
Santa Catarina, Brazil*

Abstract—Forty-seven species of wood inhabiting Basidiomycetes are reported from the Atlantic Rain Forest of the Parque Estadual da Serra do Tabuleiro, Santa Catarina, Brazil. Fourteen are new records for the state. All the species are new records for the studied area. The complete checklist is available on <http://www.mycotaxon.com/resources/weblists.html>.

Key words—wood rot Basidiomycetes, checklist, xilophilous

Introduction

The macrofungi have perhaps the longest history of diversity studies of any mycota. Nevertheless, they are understudied over most of the world. Taxonomic obstacles and the absence of long-term studies prevent conclusive answers even to basic questions about the number of species at a specific location or whether diversity is greater in one type of forest than in another (Lodge et al. 2004). It is known that the species of lignocellulolytic basidiomycetes are extremely abundant in all forest types and that they are the major wood decomposers in most ecosystems (Fryar et al. 1999). These fungi have received special attention of researchers in the last decades due to their potential applications in pollutant purification, soil bioremediation, and antibiotic production (Blanchette 1995; Kotterman et al. 1994; Smânia et al. 2003). However, in many geographical areas, especially in the tropical forest systems, it is clear that the known number of described fungal species represents only a small fraction of the number believed to exist there (Gilbert & Sousa 2002). The plant flora is better known than the fungi both in the Neotropical area (Thomas 1999) and the Brazilian Atlantic Forest. The latter is particularly relevant for studies because of its high biological diversity and severely threatened status (Tabanez & Viana 2000). An increased understanding of fungal diversity and natural history of fungi will contribute to the knowledge of the local biota and will greatly strengthen initiatives to protect and use sustainably our natural resources (Rossman et al. 1998).

According to available records, fungi were first collected in Santa Catarina State in 1815 by Adalberto de Chamisso, and only sporadically thereafter until Möller's activity in 1890 (Loguercio-Leite 1991). Starting in 1986, surveys were periodically conducted by researchers of the Mycology Laboratory (BOT/CCB/UFSC), who specifically targeted polyporoid lignocellulolytic fungi. Since then several studies have been published with data on collections from the Atlantic Forest, Santa Catarina Island, and other areas in the state. This has produced approximately 60 new species records for the state, six of which are new to science (Loguercio-Leite & Wright 1991, 1998; Loguercio-Leite et al. 1998, 2001, 2002).

Material and Methods

The Atlantic Forest is composed of two major vegetation types: the Atlantic Rain Forest and the Atlantic Semi-deciduous Forest (Morellato & Haddad 2000). The state of Santa Catarina (26°-30° S lat, 48°30'-54° W long) in Southern Brazil currently has only 17.4% of its original area covered by the Atlantic Forest (Ministério do Meio Ambiente 2002).

The present study was conducted in Parque Estadual da Serra do Tabuleiro, which belongs to the Atlantic Rain Forest region. The Parque (27° 42' 09"-28° 34' 09" S lat, 48° 57' 23"-48° 43' 09" W long), which covers 900 km² and is located at the center-east portion of the state of Santa Catarina, includes nine municipalities (Fig. 1): Palhoça, Santo Amaro da Imperatriz, Águas Mornas, São Bonifácio, Imaruí, Garopaba, Paulo Lopes, São Martinho and Florianópolis (Batista 2003).

Highly diverse, the Parque Estadual da Serra do Tabuleiro contains representatives of the different landscapes types of Santa Catarina. The diverse ecosystems and habitats support known rare, endangered and endemic species, with many new species yet to be recorded. Therefore, this area both serves as a highly important genetic reservoir and offers opportunities for biodiversity and conservation research as well (Rosário 2003).

Periodical fungal inventories were conducted between July 2000 and July 2001. Basidiomes were studied using macroscopic (e.g., size, colour, number pores/mm, length of tubes) and microscopic (presence/absence of structures, dimensions) vegetative and reproductive characters (Ryvarden 1991, Singer 1975). Measurements and drawings were made from slide preparations stained with 1% aqueous phloxine and 5% KOH. Specimens were identified to species using specialized references and comparing collections with FLOR, BAFC, ICN and PACA Herbaria collections. Vouchers were deposited in FLOR Herbarium (Universidade Federal de Santa Catarina) after examination. (Holmgren et al. 1990). Nomenclature and authorities are from Kirk et al. (2001).

Results and Discussion

In the state of Santa Catarina, 163 species of lignocellulolytic fungi (Basidiomycetes) have been recorded since 1986. In the investigated area 47 species were found, representing about 28 percent of the total number of polypores reported for the State, until now. Those species are distributed in 29 genera and 11 families. Fourteen of the identified species are new records for the State and are marked with * in the checklist. All species are new citations for the area.



Figure 1 – Map of the State of Santa Catarina showing the areas of Atlantic Rain Forest and Parque Estadual da Serra do Tabuleiro.

As this study was based on collecting during a period of 13 months and, as some fungi form its basidiomes irregularly, many species were probably unrecorded. Mycelia belonging to a species with low productivity may exist in the substrate over many years but only rarely produce basidiomes except under optimal conditions (Straatsma & Krisai-Greilhuber 2003).

Thirty-two (68%) of the species collected in the Parque Estadual da Serra do Tabuleiro, show a tropical (neotropical and pantropical) distribution, while four [*Amauroderma corneri* Gulaid & Ryvarden, *Antrodiella multipileata* L. Leite & Wright, *Henningsia brasiliensis* (Speg.) Speg., *Skeletocutis roseolus* (Rick ex Theissen) Rajch.] are known only from Brazil. Fifteen (32%) species are cosmopolitan.

The genera with the largest number of species (4) were *Ganoderma* and *Phellinus*. *P. grenadensis* was most frequent (8), mostly on trunks of *Piptadenia gonoacantha*. However, host data are poor in the tropics, particularly as the great diversity of species makes host identification difficult, particularly when basidiomes fruit on dead trees or fallen trunks (Gilbert et al. 2002).

This study substantially increases the geographic ranges of the lignocellulolytic fungi. Obviously more work is required to increase our knowledge on these fungi at the Park, an area of extreme biological importance.

Checklists for all species can be found at: <http://www.mycotaxon.com//resources/weblists.html>

Acknowledgements

The authors thank Leif Ryvarden and Jorge E. Wright (deceased) for reviewing the manuscript.

Literature cited

- Batista MR. 2003. Caracterização geográfica. In: Fundação do Meio Ambiente. A natureza do Parque Estadual da Serra do Tabuleiro. Florianópolis: FATMA. 128 p.
- Blanchette RA. 1995. Degradation of the lignocellulose complex in wood. Canadian Journal of Botany 73 (suppl. 1): 999-1010.

- Fryar SC, Kirby GC, Hyde KD. 1999. Species abundance patterns of two wood decay basidiomycete communities. *Fungal Diversity* 3: 39-56.
- Gilbert GS, Sousa WP. 2002. Host specialization among wood-decay polypore fungi in a Caribbean mangrove forest. *Biotropica* 34(3): 396-404.
- Gilbert GS, Ferrer A, Carranza J. 2002. Polypore fungal diversity and host density in a moist tropical forest. *Biodiversity and Conservation* 11: 947-957.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. *Index Herbariorum*. Pt. 1. The Herbaria of the World. International Association for Plant Taxonomy, New York Botanical Garden, New York. 693 p.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9ª edição; CAB International.
- Kotterman M, Heessels E, Jong E, Field JA. 1994. The physiology of anthracene biogradation by the white rot fungus *Bjerkandera* sp. Strain BOS55. *Applied Microbiology and Biotechnology* 42: 179-186.
- Lodge DJ, Ammirati JF, O'Dell TE, Mueller GM. 2004. Collecting and describing macrofungi. In: Mueller GM, Bills GF, Foster MS. *Biodiversity of fungi: inventory and monitoring methods*. Elsevier Academic Press, Oxford, UK. 777 p.
- Loguercio-Leite C. 1991. Revisão histórica sobre fungos poliporóides (*Aphyllphorales*) xilófilos de Santa Catarina, Brasil. *Ínsula* 20: 3-10.
- Loguercio-Leite C, Wright JE. 1991. New South American Pileate Polypores (*Polyporales*) from Santa Catarina Island, SC, Brazil. *Mycotaxon* 41(1): 167-172.
- Loguercio-Leite C, Wright JE. 1998. *Diplomitoporus dilutabilis* a new species of *Polyporales* (*Aphyllphorales*) from Santa Catarina Island, Brazil. *Mycotaxon* 68: 47-51.
- Loguercio-Leite C, Gerber A, Ryvarden L. 1998. *Wrightoporia porilacerata*, a new species of pore fungi from southern Brazil. *Mycotaxon* 67: 251-255.
- Loguercio-Leite C, Gonçalves GVC, Ryvarden L. 2001. Studies in Neotropical polypores 13. *Ceriporiopsis cystidiata* sp. nov. *Mycotaxon* 79: 285-288.
- Loguercio-Leite C, Ryvarden L, Groppo C. 2002. Studies in neotropical polypores 16. *Rubroporus carneoporis* genus & species nova. *Mycotaxon* 83: 223-227.
- Ministério do Meio Ambiente. 2002. Biodiversidade Brasileira: avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição de benefícios da biodiversidade brasileira. Brasília, MMA/SBF. 404 p.
- Morellato LPC, Haddad CFB. 2000. Introduction: the Brazilian Atlantic Forest. *Biotropica* 32(4b): 786-792.
- Rosário LA. 2003. Paisagem e Conservação. In: Fundação do Meio Ambiente. A natureza do Parque Estadual da Serra do Tabuleiro. Florianópolis: FATMA. 128 p.
- Rossman AY, Tulloss RE, O'Dell TE, Thorn RG. 1998. Protocols for an all taxa biodiversity inventory of fungi in a Costa Rican conservation area. Parkway Publications, Inc., Boone, North Carolina. 163 p.
- Ryvarden L. 1991. Genera of Polypores – Nomenclature and taxonomy. *Synopsis Fungorum* 5. Fungiflora, Oslo, 363 p.
- Singer R. 1975. The *Agaricales* in modern taxonomy. 2 ed. Rev. J. Cramer, Weinheim, 912 p.
- Smânia A, Marques CJS, EFA Smânia, Zanetti CR, Carobrez, SG, Tramonte R & Loguercio-Leite C. 2003. Toxicity and antiviral activity of cinnabarin obtained from *Pycnoporus sanguineus*. *Phytoth. Res.* 17: 1069-1072.
- Straatsma G, Krisai-Greilhuber I. 2003. Assemblage structure, species richness, abundance, and distribution of fungal fruit bodies in a seven year plot-based survey near Vienna. *Mycological Research* 107(5): 632-640.
- Tabanez AAJ, Viana VM. 2000. Patch structure within Brazilian Atlantic forest fragments and implications for conservation. *Biotropica* 32(4b): 925-933.
- Thomas WW. 1999. Conservation and monographic research on the flora of Tropical America. *Biodiversity and Conservation* 8: 1007-1015.

Moist Chamber Culture and Field Collections of Myxomycetes from Ecuador

ROLAND MCHUGH

Roland.mchugh@dit.ie

Dublin Institute of Technology

Cathal Brugha Street, Dublin 1, Ireland

Abstract—This study presents the results of a visit to Ecuador undertaken in June–July 2003 with the objective of obtaining and identifying myxomycetes. Field collecting was confined largely to the Pacific coast, particularly around the village of Ayampe. Bark from living trees in this region was collected for subsequent moist chamber culture. A number of lianas from the Amazonian rainforest in the east of the country were collected during the visit and these also were subjected to moist chamber culture. A total of sixty-one myxomycete species was obtained, of which sixteen were new to Ecuador

Introduction

Ecuador can claim very few examples to date of myxomycetes obtained through the moist culture of bark from living trees, a technique which has provided numerous records from other parts of the world. Schnittler, Lado & Stephenson (2002) prepared 76 bark cultures from the Maquicupuna Cloud Forest Reserve in the Andes near Quito, but obtained only eight myxomycete species. This accords with the general observation that bark cultures are unproductive in areas of high rainfall (Schnittler & Stephenson 2000). It was therefore decided by the present author to take bark samples for culture from dry tropical forest in the vicinity of the Machalilla National Park on the Ecuador coast. A visit to this region was made in June–July 2003 and, in addition to bark samples, field collections of myxomycetes were also made. Whilst Schnittler et al. (2000) obtained poor results with the culture of bark from Maquicupuna, they had better luck in culturing other substrates such as leaf litter. Nieves-Rivera et al. (2003) showed that the culture of portions of rainforest lianas could produce abundant myxomycete fruitings. Therefore whilst visiting Ecuador, a quantity of liana material was gathered in the neighbourhood of Yachana Lodge in the Amazonian rainforest, for subsequent moist culture.

Together with a few additional field collections, the results of these investigations are presented here.

Materials and Methods

Study Areas - The greater part of the collecting in coastal Ecuador was centred on the village of Ayampe (1°39'S; 80°47'W) on the road from Manta to Salinas.

Accommodation was obtained in the Finca Punta Ayampe estate directly overlooking a beach fringed with *Thespesia* sp. bushes robust enough to provide bark. The estate and adjacent hills were wooded, with a high diversity of tree species, and bark was obtained from here also. South of Ayampe the coast road climbs and the humidity increases: much larger trees were encountered 4 and 5 km south of the village and some bark taken here. About 14 km north of Ayampe the Machalilla National Park meets the coast near Puerto Lopez and continues as far as the village of Machalilla. 10 km further north (1°21'S; 80°43'W) more bark was collected; trees here are low and scrubby and there is abundant cactus (*Armatocereus*), from which some dead surface material was removed for moist culture. Finally, 20 km north of the turnoff for Jipijapa (1°7'S; 80°34'W) the terrain is semidesert with the Kapok Tree (*Ceiba*) the only large species: the bases of old *Ceiba* trunk spines were cultured.

On 2 July weather conditions at Ayampe, which had previously been damp, became dry and this appeared to trigger a massive fruiting of Physarales. The following day in undisturbed parts of the Finca Punta Ayampe estate a great abundance of sporocarps covered sticks, leaves, moss and bare earth. A similar situation was encountered beside the Ayampe river over 1 km away. The density and extent of fructifications resembled that seen in Alpine situations where snowline species display their characteristic transient ostentation. Numerous sporocarps were collected but they proved to be chiefly four species, plus two additional ones.

In addition to the Pacific coast, two other sites in Ecuador were visited. Yachana Lodge (0°50'S; 77°12'W) is situated on the north bank of the river Napo in secondary rainforest in the buffer zone of the Gran Sumaco National Park. In addition to the liana material mentioned above, four myxomycete species were collected here on fallen timber. El Boliche National Recreation Area in the Andes south of Quito (0°23'S; 78°25'W) includes a woodland path where three myxomycetes were collected on unidentified stumps.

Collection Technique - Field collections were made by removing portions of substrate together with attached myxomycetes, and securing them with beadheaded pins in a corklined box. For moist cultures, bark (preferably with epiphytic lichens and bryophytes) was removed from individual trees at a selection of heights and aspects, using a chisel. It was immediately sealed in small envelopes. Liana and cactus material was transported similarly. To set up cultures, the material was placed on filterpaper discs in Petri dishes, flooded with distilled water, and the excess liquid poured off after 24 hours. The dishes were kept at room temperature in dim light and periodically sprayed with more water to maintain a high humidity. The normal policy was to maintain cultures for about three months and to continue after this only if plasmodia were conspicuous. Frequent scanning with an Olympus SZX12 stereoscope revealed developing myxomycetes. These were removed together with their substrates, glued into matchboxes and airdried. Field collections were preserved similarly. Microscopic preparations employed lactophenol, or for limy species Hoyer's reagent.

Identification of Substrates - No attempt was made to determine lianas, but trees and cacti were usually identifiable at least to family with Gentry's field guide (1993).

Results

The list of species obtained employs the nomenclature of Lado (2001). Colours are identified in accordance with the coding of Kornerup & Wanscher (1967). For each collection an initial abbreviation specifies the origin of the material and is followed by the author's herbarium number, plus additional comments if appropriate. The following initial abbreviations are used:

Sources of moist chamber culture from the Pacific coast

Each entry represents a single collection and is followed by two numbers, the first being the number of dishes PREPARED and the second the number of dishes providing any evidence of MYXOMYCETE ACTIVITY.

AB *Anacardiaceae* or *Burseraceae* (these families hard to distinguish). Ayampe river, 3 July. 10/7

AM *Armatocereus* (*Cactaceae*). 10 km N. of Machalilla, 4 July. 15/15

CA *Ceiba* (*Bombacaceae*) trunk spines. Near cabin, Ayampe, 3 July. 1/1

CS *Chrysophyllum* (*Sapotaceae*). Beside coast road 5 km S. of Ayampe, 5 July. 3/3

CJ *Ceiba* (*Bombacaceae*) bases of old trunk spines. Beside coast road 20 km N. of Jipijapa turnoff, 4 July. 12/12

DA *Dilodendron* (*Sapindaceae*). Near cabin, Ayampe, 3 July. 7/4

DS *Dichapetalaceae*. Beside coast road 4 km S. of Ayampe, 5 July. 6/4

FA *Flacourtiaceae*. Near cabin, Ayampe, 1 July. 4/3

JM *Jacquinia* (*Theophrastaceae*). 10 km N. of Machalilla, 4 July. 2/2

LA *Lecythidaceae*. Near cabin, Ayampe, 3 July. 10/10

MA *Malvaceae*. Near cabin, Ayampe, 3 July. 3/3

PA *Polygonaceae*. Steps to viewpoint, S. Ayampe beach, 1 July. 4/4

RA *Rutaceae*. Near cabin, Ayampe, 3 July. 9/7

RM *Rubiaceae*. 10 km N. of Machalilla, 4 July. 3/3

TA *Thespesia* (*Malvaceae*). Ayampe beach, 1 July. 9/9

VA *Vismia* (*Guttiferae*). Steps to viewpoint, S. Ayampe beach, 1 July. 9/9

XA Unidentified. Near cabin, Ayampe, 3 July. 4/3

XM Unidentified, 10 km N. of Machalilla, 4 July. 2/2

Field Collections

AFC Near cabin, Ayampe, 3 July.

RFC Beside Ayampe river, 3 July.

BFC El Boliche, 22 June.

YFC Yachana Lodge, 25 June.

Lianas for moist culture

Individual lianas are numbered La to Li; they were collected on 26 June at Yachana Lodge. La to Lg were living, Lh and Li dead.

Annotated Species List

Echinosteliales

Echinostelium apitectum K.D. Whitney: VA936—New to Ecuador.

E. arboreum H.W. Keller & T.E. Brooks: CJ981—New to Ecuador.

Liceales

Cribraria violacea Rex: AM1065, LA979—The most common bark species in Costa Rican dry coastal forests (Schnittler & Stephenson 2000).

Licea biforis Morgan: DA957, FA963, RA940, TA949

L. cf. longa Flatau: XA941—About 1 mm tall and developing from an orange plasmodium, this single sporocarp differs slightly from typical material (Flatau, 2000). The sporotheca is ochraceous (4B4) and about 350 μm in diam. A series of bands of refuse matter (granules ca. 3 μm across) radiate from the base of the sporotheca and are 18–20 μm wide (in typical material ca. 10 μm). The intervening clear peridium bears small (ca. 1 μm) warts and is of similar width to the bands. The base of the sporotheca in Flatau's illustration is darker than the rest whereas here the colour is uniform. The stalk measures 800 μm by 200 μm and bears vertical ribs; the spore is smooth and almost colourless, 10–11 μm diam. First record outside Europe. (Fig. 1a).

L. operculata (Wingate) G.W. Martin: DS990, MA928, RA925, VA922

L. pedicellata (H.C. Gilbert) H.C. Gilbert: CA955 (spores very pale), CJ984, LA933, PA923, RM931, XM1066—New to Ecuador.

L. perexigua T.E. Brooks & H.W. Keller: XM993—This material corresponds well to the original description apart from the spore size of 11–13 μm , instead of 8.5–10.5 μm . In this it resembles the '*cf. perexigua*' noted by Schnittler et al. (2002), but this has inconspicuous peridial ornamentation whereas the papillae here are clearly defined.

L. scyphoides T.E. Brooks & H.W. Keller: DA956, RM931, XM970—New to Ecuador.

L. cf. scyphoides: LA952—This single sporocarp closely resembles *L. scyphoides*, with a stalk 140 μm high, but has a paler spore colour resembling that of *L. perexigua*. The papillae of the inner peridium are very conspicuous, being 1–2 μm high.

L. succulenticola Mosquera, Lado, Estrada-Torres & Beltrán-Tej.: AM1025—The species appears to be comparatively common on cactus cultures, but this record is the first for the Southern Hemisphere, suggesting the limited extent to which such methods have been employed there.

L. sp.: TA930—Sporocarps scattered, brown, 0.1–0.2 mm diam. (Fig. 2a). Peridium double, the outer peridium ca. 10 μm thick, pale yellow (3A4) in transmitted light and containing coarse refuse matter. Dehiscence circumscissile, the upper half of the outer peridium being shed, leaving the remainder as a brown to black (6E2) cup with the rim bent outwards, from which the brown (5D5) spore mass bulges out, contained in the iridescent inner peridium, which is pale yellow (3A2–3) in transmitted light and also contains refuse matter. Spore smooth, 11–13 μm , very pale grey and lacking

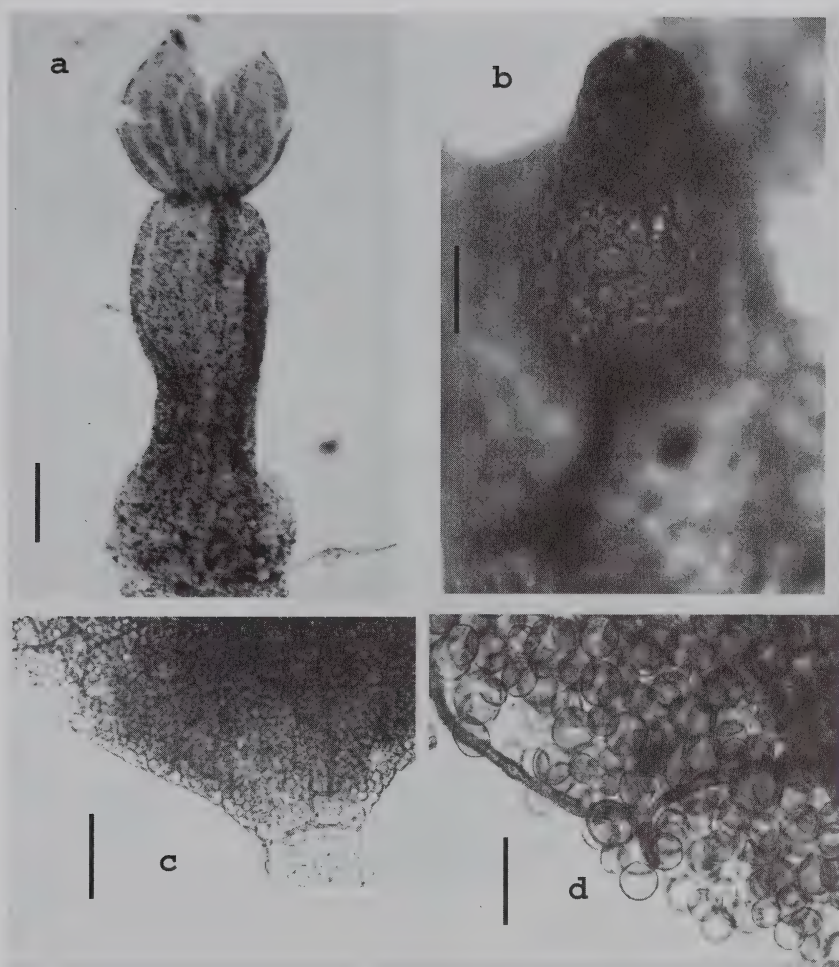


Fig. 1. **a.** *Licea* cf. *longa* (XA941) sporocarp in lactophenol. Scale bar = 150 μm **b-d.** *Arcyria* sp. (La1043). **b.** Whole sporocarp. Scale bar = 300 μm . **c.** Base of sporotheca in lactophenol. Scale bar = 100 μm . **d.** Portion of sporotheca in lactophenol. Scale bar = 20 μm .

a germination pore. Macroscopically it resembles a *Licea* found by Eliasson (2000) on dried herbarium specimens of *Grias* leaves from Ecuador, and labeled E5426, but Eliasson's material has a quite distinct lid and a larger spore (14.5–15 μm). This collection was accompanied by some effuse material superficially resembling *L. variabilis* Schrad.

Lycogala confusum Nann.-Bremek. Ex Ing: BFC910, YFC911 — New to Ecuador.

L. epidendrum var. *terrestre* (Fr.) Y. Yamam.: BFC909 — Earlier records of *L. epidendrum* should probably be assigned to this; see Ing (1999).

Trichiales

Arcyria cinerea (Bull.) Pers.: AB974, CJ983, CS1014, FA972, RA965, La1042.

_____ var. *digitata* (Schwein.) Rostaf.: AB974, FA994, RA965, La1042.

_____ f. *rubella* Y. Yamam.: Lh1082—Sporocarps scattered, 0.5-1.0 mm high, initially pink (7A4), fading to ochre (5A3). Stalk and calyculus red-brown, 1-2 times the diameter of sporotheca. Capillitium 2-3 μm diam., nearly colourless, densely spinulose. Spore nearly colourless, with irregularly scattered warts, 7-10 μm . New to Ecuador.

A. denudata (L.) Wettst.: AB1038, YFC914

A. sp.: La1043—Sporocarps solitary, stipitate, 1.0-1.3 mm high (Fig. 1b, c, d). Sporotheca ovoid, ca. 0.5 mm wide at base, 0.3 mm at tip, dull brown (5E4). Stalk half to two thirds height of sporotheca, dark brown, translucent to opaque, filled with cysts mostly 10-20 μm across. Peridium persistent, colourless, iridescent in reflected light, inner surface papillose. Capillitium not expanding, composed of rigid branching threads ca. 3 μm diam., dull yellow (3B5), with free ends. In one sporocarp examined the capillitium is entirely smooth. In another it is unornamented in the lower part of the sporotheca, but otherwise bears a dense layer of spines ca. 1 μm long. (Keller and Whitney (1986) observe a similar tendency in *A. nigella* Emoto and *A. pausiaca* Keller & Buben-Zurey.) Spore light greyish yellow (4B3), irregularly warted, (10)13-14 (15) μm diam.

A. sp.: Lg1061—Sporocarps solitary, stipitate, 0.6-1.0 mm high (Fig. 2b, c). Sporotheca globose, 200-330 μm diam., ochraceous (3B3-4). Stalk 300-500 μm high, width ca. 50 μm , and of same colour, filled with cysts mostly 10-17 μm across. Peridium evanescent, leaving a shallow calyculus with the inner surface minutely papillose. Capillitium hardly expanding, composed of rigid branching threads ca. 3 μm in diam., pale yellow (3B3) and densely covered throughout with minute spines. Spore light greyish yellow (4B3), with irregularly placed patches of small warts, (9)10-11(12) μm diam.

Calomyxa metallica (Berk.) Nieuwl.: AB966, LA978, RA926, PA927, VA976, XM1011—Very common on bark cultures. It seems strange that it has not previously been reported from Ecuador.

Hyporhamma (*Hemitrichia*) *calyculata* (Speg.) Lado: YFC 913

H. pardina (Minakata) Lado: DA1026, La1078, Lc1084

Perichaena chrysosperma (Curr.) Lister: AB939, LA934, RA996, RM935, XM1010, Lh1076* (*see discussion)

P. corticalis (Batsch) Rostaf.: CJ995, DA968, PA942

P. depressa Lib.: AB1057, LA1037

P. pedata (Lister & G. Lister) G. Lister ex. E. Jahn, AB967, RA943, VA950, La1040* (*see discussion)

P. dictyonema Rammeloo: AM1018, Lb1041—Sporocarps scattered, occasionally joined in pairs, 0.1-0.5 mm diam., round to oval when viewed from above, pulvinate to cylindrical in side view, the lid bulging conspicuously (Fig. 2d). The spore mass, visible between the base and lid, is bright ochre (4A7) as in Rammeloo's (1981)

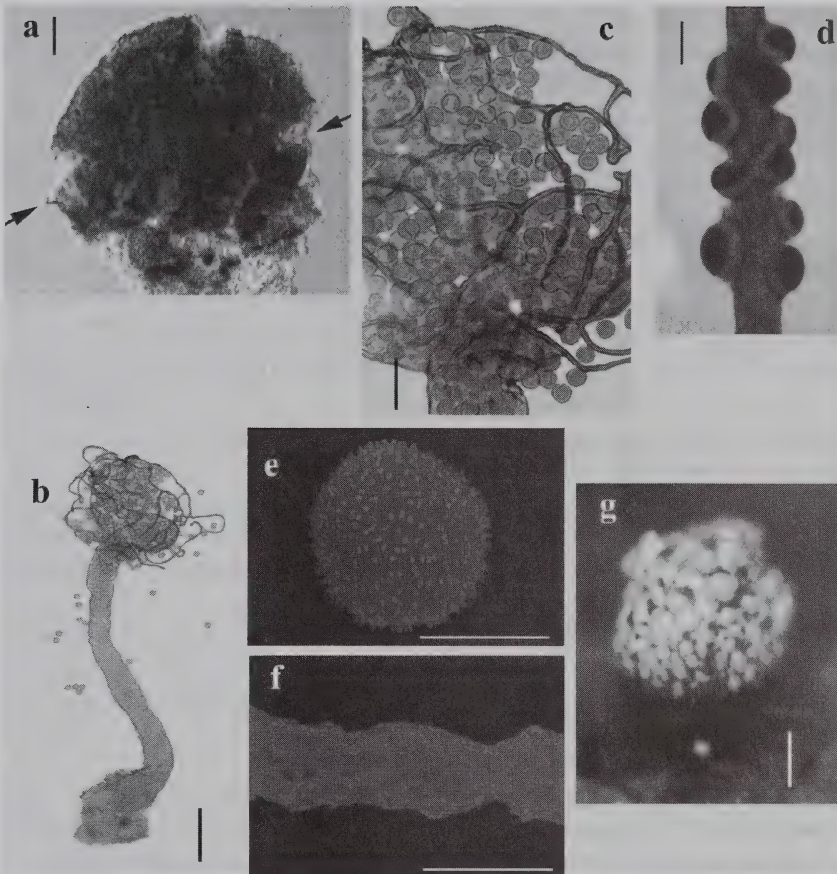


Fig. 2. **a.** *Licea* sp. (TA930) sporocarp in lactophenol, DIC. Arrows indicate rim of cup. Scale bar = 65 μ m. **b, c.** *Arcyria* sp. (Lg1061) sporocarp in lactophenol. **b.** Scale bar = 100 μ m. **c.** Scale bar = 30 μ m. **d-f.** *Perichaena dictyonema*. (AM1018). **d.** Whole sporocarps. Scale bar = 300 μ m. **e.** Spore, SEM. Scale bar = 10 μ m. **f.** Capillitium, SEM. Scale bar = 5 μ m. **g.** *Physarum* sp. (Li1059). Whole sporocarp. Scale bar = 250 μ m.

description, but he gives the lid a range of colours from dark brown (6F5) to a clearer 5B6, whereas the lids in the present collection range from dark brown to light grey (4B2), the lighter colour accompanied by a much rougher breadcrumb-like texture and suggesting the presence of lime in the lid. This is confirmed by the appearance of bubbles when the material is placed in lactophenol. The spores (10–12 μ m diam.) display uniform spines ca. 0.5 μ m in length (Fig. 2e) and the capillitium bears an irregular net (Fig. 2f).

P. vermicularis (Schwein.) Rostaf.: AM1008

Physarales

Badhamia panicea (Fr.) Rostaf.: AM1039, JM992

Craterium leucocephalum (Pers. Ex J.F.Gmel.) Ditmar: AF918

Diderma chondrioderma (de Bary & Rostaf.) G. Lister: MA959

D. cingulatum Nann.-Bremek.: CJ1017—Buyck (1988) regarded the record of *Diderma rimosa* from the Galapagos Islands (Eliasson and Nannenga-Bremekamp, 1983) as being this species, but Lado (2001) distinguishes them. The present material is characteristic *cingulatum*, with a tall columella and a peridial surface resembling drifted snow. New to Ecuador.

D. effusum (Schwein.) Morgan: CJ999, RA973, VA960

D. hemisphaericum (Bull.) Hornem.: CJ1003, MA951, PA944, RA997

Didymium applanatum Nann.-Bremek.: AF919, RF919—Also known from France and Holland. New to the Americas.

D. difforme (Pers.) Gray: CS1004

D. iridis (Ditmar) Fr.: CS1005, DS1001

D. cf. iridis: Lb1080—This collection approximates *D. bahiense* Gottsb., regarded as genetically identical with *iridis*; see for example Ing (1999). However, the peridium displays the patchy markings typical of *D. nigripes* and the lime crystals are rhomboidal rather than needle-shaped.

D. ochroideum G. Lister: CJ1000, Lh1079

D. nigripes (Link) Fr.: AF916

D. squamulosum (Alb. & Schwein.) Fr.: CS988, MA977, RF921, TA964

D. verrucosporum A.L.Welden: PA945

***Physarum album* (*nutans*)** (Bull.) Chevall.: BFC908

P. bivalve Pers.: AF917—Farr et al. (1979) note an Ecuador *Physarum* species ‘Close to *P. bivalve*’, but otherwise no records exist from Ecuador.

P. compressum Alb. & Schwein.: AM1012, CS1013, JM962, TA961, Lb1077, Li1058—In great abundance whenever present.

P. crateriforme Petch.: CA980, MA938

P. didermoides (Pers.) Rostaf.: AM1067, CJ1074, JM1020, Lc1075

P. echinosporum Lister: XA991—A tropical species with a very distinctive spore. New to Ecuador.

P. lakhanpalii Nann.-Bremek. & Y. Yamam.: TA998—New to Ecuador. A largely tropical species resembling *P. decipiens* but with clustered spores.

P. leucophaeum Fr.: AB975, AM1006, CJ986, LA937, MA989, PA924, XM987

P. melleum (Berk. & Broome) Masee: AF915, RF915

P. nucleatum Rex: YFC912

P. oblatum T. Macbr.: AM1019, CJ982, DA969, MA954, TA971—This material is identical with that described by Schnittler et al (2002) as a yellow *P. pusillum*.

P. pusillum (Berk. & M.A.Curtis) G. Lister: AM1007, La1027, Le1044

P. viride f. *incanum* (Lister) Y. Yamam.: DA1021

P. xanthinum Nann.-Bremek. & Döbbeler: LA953—New to Ecuador. Material confirmed by comparison with specimen loaned by D.W. Mitchell.

Physarum sp.: Li1059—Sporocarps solitary, sessile, 0.5–1.0 mm high, 0.2–0.4 mm wide, dark (5E6) and iridescent basally but the upper half caked with yellow (4A5) lime scales as in *P. limonium*, the colour fading in time (Fig. 2g). Peridium yellow (4A5) in transmitted light, limenodes yellow, rounded to angular, connected by hyaline threads. Spore grey to brown in transmitted light, minutely roughened, 8–9 μm .

Trabrooksia applanata H.W. Keller: XA948—Lado (2001) includes this in *Didymium sturgisii* Hagelst. but this material appears much closer to the typical *Trabrooksia*. This seems to be the first record for the Southern hemisphere; a second collection from Ecuador (Yasuni National Park) is due to Schnittler (pers. comm., 2004).

Stemonitales

Collaria arcyronema (Rostaf.) Nann.-Bremek. ex Lado: AB1054, CJ1023, TA1002, Lf1054

Colloderma oculatum (C. Lippert) G. Lister: AM1022, CS1016, MA1015, XA947. A common species, but new to Ecuador.

Comatricha elegans (Racib.) G. Lister: FA929, LA944

Macbrideola martinii (Alexop. & Beneke) Alexop.: CJ985, LA958. Not unusual in the Americas but new to Ecuador.

Stemonitis flavogenita E. Jahn: DA1064, TA1009

S. fusca Roth: VA1024—This is the small 'fusca' previously known as *S. nigrescens* Rex.

Discussion

The longest list of Ecuador myxomycetes to date is that of Farr (1976), but the total count has since increased substantially and is given as 87 species for the mainland in the study of Maquipucuna by Schnittler et al (2002), which added 30 taxa, of which 23 could be clearly assigned to described species. The present study adds a further 16 species.

Eighteen trees and one cactus from the coastal area produced myxomycetes, although in one case (*Triplaris* sp. from a site 4 km south of Ayampe) only plasmodia appeared on the cultures, none of them fruiting after 6 months. Two further cultures (*Cunoniaceae* and *Mimosoideae*) failed to give any myxomycetes; the former came from the same site as the *Triplaris*, the latter (from the site 10 km north of Machalilla) was rapidly colonized by moulds and had to be abandoned. A few individual dishes were overrun by springtails but usually the myxomycetes did not appear to be damaged by the presence of arthropods etc. 85.4% of all dishes with material from the coast produced some myxomycete activity, though not always mature sporocarps.

The Maquipucuna observations do show interesting similarities with those here presented, as was observed above under '*Licea perexigua*'. Schnittler et al. (2002) further state that 'Some members of the Physarales with large plasmodia and which typically

inhabit forest floor litter were found in the field only (*Craterium leucocephalum*, 26 records; *Didymium nigripes*, 15 records and *Physarum melleum*, 13 records). These constitute three of the four species abundant in the mass fruiting at Ayampe; the other one (*P. bivalve*) was absent from the Maquipucuna list.

Whilst the coastal collections of *Perichaena pedata* appeared normal, the collections from lianas tended towards *P. chrysosperma*: distinctions between the species are not always clear. (Some of the Maquipucuna records display the same tendency, in respect of capillitial spines). A few *P. pedata*-like individuals accompanied the *P. chrysosperma* collection Lh1076, which were mostly the typical sessile, often ring-shaped sporocarps largely covered above by dark brown outer peridium, and showing the shiny orange inner peridium beneath, plus a spiny capillitium. On the other hand some *P. pedata* sporocarps from Ld1040 were also short-stalked to sessile with spiny capillitium, and some neighbouring ones long-stalked, with the capillitium smooth or bearing occasional long spines. As stalk length increased, the area covered by the outer peridium was reduced, and this layer increasingly broke into patches. The greatest reduction was seen in examples which were multi-lobate, recalling the initial description of *P. pedata* by A. and G. Lister (1904), describing a collection from Philadelphia: 'they are either solitary or in clusters of two to three on a single stalk, or sessile'. Lister (1925) subsequently absorbed *P. pedata* into *P. chrysosperma* and was followed in this by Martin and Alexopoulos (1969). Further discussion is summarized in Rammeloo (1984).

A striking aspect of the coastal records is the high count of *Physarales* and very low count of *Stemonitales*. Listing numbers in the sequence *Echinosteliales*, *Liceales*, *Trichiales*, *Physarales* and *Stemonitales*, the coastal totals are 2, 9, 10, 26, 6, to be compared with those from Maquipucuna of 1, 8, 16, 36, 17. This again gives prominence to the *Physarales*, but also presents a high proportion of *Stemonitales*. Clearly too many factors are involved to justify the positing of explanations, but it is noteworthy that moist chamber cultures from maritime dry forest and tropical rainforest in Costa Rica (Schnittler & Stephenson, 2000) gave ratios not dissimilar to the above, i.e. 2, 6, 7, 14, 5, and a further series from the Tanzanian coast (Ukkola 1998) gave 4 *Liceales*, 6 *Trichiales* and 9 *Physarales* with no *Echinosteliales* or *Stemonitales*. The investigation of dry forest and tropical rainforest in coastal Mexico by Lado et al. (2003) did not however show any paucity of *Stemonitales*.

The most common species from the present coastal moist cultures are *Calomyxa metallica*, *Licea pedicellata*, *Perichaena chrysosperma* and *Physarum leucophaeum* (all with 6 records), *Physarum oblatum* and *Arcyria cinerea* (both with 5). The first four of these are absent from the Maquipucuna list and the first three also from that of Ing and Haynes (1999) in Belize. *Calomyxa* was, however, found on a bark culture from El Eden, coastal Mexico, by Lado et al (2003). On the other hand the generally ubiquitous *Echinostelium minutum* found in both coastal areas in the Mexican study by Lado et al (2003) was lacking from all present cultures.

The most interesting feature of the rainforest liana cultures is the appearance of three undescribed species, two *Arcyria* and one *Physarum*, but in numbers too small to justify naming them at present. Other *Arcyria* species were more abundant and this genus

appears significantly commoner here than at the coast. Several quite unusual species have appeared in both regions, notably *Perichaena dictyonema*. However, a meaningful picture will emerge only when considerably more collections have been made. Ecuador clearly shows great potential for the study of myxomycetes.

Acknowledgements

For assistance and encouragement with the foregoing study the author wishes to thank Uno Eliasson, Tony Hutchinson, Carlos Lado, David Mitchell, Martin Schnittler, Diana Wrigley de Basanta and Yukinori Yamamoto.

Literature cited

- Buyck B. 1988. The *Diderma spumarioides-globosum* complex (Myxomycetes). Bulletin de Jardin Botanique National de Belgique 58:169-218.
- Eliasson U. 2000. Myxomyceten auf lebenden Blättern im tropischen Regenwald Ecuadors. Stapfia 73: 81-84.
- Eliasson U, Nannenga-Bremekamp E. 1983. Myxomycetes of the *Scalesia* forest, Galápagos Islands. Proceedings of Koninklijke Nederlandse Akademie van Wetenschappen C86: 143-153.
- Farr ML. 1976. Flora Neotropica Monograph 16 Myxomycetes. New York Botanical Garden, New York.
- Farr ML, Eliasson U, Dumont KP. 1979. Myxomycetes from Ecuador. Mycotaxon 8: 127-134.
- Flatau L. 2000. Die Gattung *Licea* im Fuldatal bei Kassel (Myxomyceten). Stapfia 73: 63-74.
- Gentry A H. 1993. A field guide to the families and genera of woody plants of northwest South America. University of Chicago, Chicago.
- Ing B. 1999. The Myxomycetes of Britain and Ireland. Richmond Publishing, Slough.
- Ing B, Haynes C. 1999. Corticolous Myxomycetes from Belize. Kew Bulletin 54: 723-730.
- Keller HW, Whitney KD. 1986. Corticolous Myxomycetes IX. Two species of *Arcyria*, one new, one old. Mycologia 78: 432-438.
- Kornerup A, Wanscher JH. 1967. Methuen Handbook of Colour. 2nd ed. Methuen, London.
- Lado C. 2001. Nomenmyx. A nomenclatural taxabase of Myxomycetes. CSIC, Madrid.
- Lado C, Estrada-Torres A, Stephenson SL, Wrigley de Basanta D, Schnittler M. 2003. Biodiversity assessment of Myxomycetes from two tropical forest reserves in Mexico. Fungal Diversity 12: 67-110.
- Lister A. 1925. A Monograph of the Mycetozoa, 3rd ed. British Museum (Natural History), London.
- Lister A, Lister G. 1904. Notes on Mycetozoa. Journal of Botany 42: 129-140
- Martin GW, Alexopoulos CJ. 1969. The Myxomycetes. University of Iowa, Iowa
- Nieves-Rivera A, Stephenson SL, Wrigley de Basanta D. 2003. Living and dead lianas as a special microhabitat for Myxomycetes in tropical forests. Inoculum 54 (3): 38.
- Rammeloo J. 1981. Flore illustrée des champignons d'Afrique centrale: 135-169, Trichiales (Myxomycetes). Jardin Botanique National de Belgique, Meise.
- Rammeloo J. 1984. *Perichaena pedata* in Icones Mycologicae 56. Jardin Botanique National de Belgique, Meise.
- Schnittler M, Lado C, Stephenson SL. 2002. Rapid biodiversity assessment of a tropical Myxomycete assemblage – Maquipucuna Cloud Forest Reserve, Ecuador. Fungal Diversity 9: 135-167.

- Schnittler M, Stephenson SL. 2000. Myxomycete biodiversity in four different forest types in Costa Rica. – *Mycologia* 92: 626-637.
- Ukkola T. 1998. Some Myxomycetes from Dar es Salaam (Tanzania) developed in moist chamber cultures. *Karstenia* 38 :27-36.

A new species of *Lentinus* from India

T. K. ARUN KUMAR & P. MANIMOHAN

pmanimohan@rediffmail.com

Department of Botany, University of Calicut
Kerala, 673 635, India

Abstract—*Lentinus bambusinus* sp.nov. is described, illustrated, and discussed based on collections made in Kerala State, India.

Key words—*Polyporaceae*, *Polyporales*, Basidiomycota

Introduction

Immediately after sending a preliminary account of the genus *Lentinus* sensu Pegler (*Polyporaceae*, *Polyporales*, Basidiomycota) in Kerala State, India for publication (Manimohan et al. 2004), collections of a new and remarkable species of the genus were made as part of a continuing study of the agaric mycota of this region. It is described, illustrated and discussed below.

Microscopic observations were made on material mounted in 3% aqueous KOH. Colour codes refer to Kornerup & Wanscher (1978). Collections examined are deposited either in the National Herbarium of the Netherlands, Leiden (L) or in second author's personal herbarium.

Description of new species

Lentinus bambusinus T.K.A. Kumar & Manim. **sp.nov.**

FIGURE 1

Etymology: *bambusinus* (L), belonging to bamboo

Pileus 1.5–20 cm *latus*, *primo convexo-umbilicatus*, *postea infundibuliformis*, *primo pallide luteus*, *postea luteoalbidus*, *primo subtiliter striatus*, *postea sulcato-striatus*, *puberulus*. *Lamellae decurrentes*, *luteoalbidae*, *confertae*, *latae*, *raro furcatae*. *Stipes* 4–10 cm x 0.5–2.5 cm, *centralis*, *primo glaber*, *postea tomentosus vel strigosus*. *Sporae* 5–6.5 x 4–4.5 μ m, *ovo-ellipsoideae*. *Cheilocystidia* 20–75 x 3–6 μ m, *versiformia*. *Gloeocystidia frequens*, 20–55 x 7–14 μ m. *Paxillae hypharum absentes*. *Trama hymenophoralis ex hyphis radiatis instructa*. *Systema hypharum dimitica*; *hyphae skeletales et hyphae generatoriae instructa*. *Pileipellis et stipitipellis e vallo trichodermiali efformata*. *Ad radices putrescens bambusarum*.

Basidiomata small to large. **Pileus** 1.5–20 cm diam., initially convex with a depressed centre, soon becoming infundibuliform; surface reddish grey (12B2) when very young, quickly becoming dull white and turning pale yellowish white (2A2) to yellowish white

(3A2) with age, with very fine appressed squamules when very young, soon appearing glabrous to the naked eye especially when wet, finely hairy under a lens, initially finely striate towards the margin, becoming distinctly sulcate-striate on maturity; margin entire and slightly incurved in very young specimens, becoming straight, finely dentate to fimbriate, and irregularly lobate when mature. **Lamellae** deeply decurrent, yellowish white (2A2), up to 1.3 cm wide, close, interveined and often dichotomously furcate, with lamellulae in 3-4 tiers; edge entire to the naked eye but finely fimbriate under a lens, concolorous to the sides. **Stipe** 4-10 × 0.5-2.5 cm, central, almost equal when young, tapering towards the base with age, terete, solid; surface initially dull white to yellowish white (4A2), finally turning brown (7E6, 7E8) to dark brown (7F8), almost glabrous in very young specimens but with age becoming tomentose, matted fibrillose or strigose and the fibrils sometimes agglutinating to form erect pointed squamules; base not arising from a sclerotium or a pseudosclerotium. **Context** up to 7 mm thick at the centre, white. **Odour** not distinctive. **Spore print** white. Basidiomata at the time of drying develop a bright yellow colour in some parts which eventually disappears in fully dried ones.

Basidiospores 5-6.5 × 4-4.5 (5.8±0.4 × 4.2±0.4) µm, Q = 1.1-1.63, Qm = 1.38, ovoid-ellipsoid, thin-walled, hyaline with large refractive guttules, smooth, inamyloid. **Basidia** 22-37.5 × 5-8 µm, narrowly clavate, with guttulate contents, 4-spored; sterigmata up to 7 µm long. Lamella-edge sterile with crowded cheilocystidia; **Cheilocystidia** 20-75 × 3-6 µm, versiform: mostly flexuose or strangulated and often branched towards the apices, rarely clavate or fusiform, thin-walled, hyaline, mostly with basal clamp-connections. **Gloeocystidia** frequently present on the edge and sides of lamellae, 20-55 × 7-14 µm, projecting up to 40 µm beyond the hymenial surface, those on the sides of lamellae mostly narrowly fusoid with rostrate or acuminate apices and those on the sides mostly pedicellate-utriform or rarely pedicellate-clavate, both types thin-walled, hyaline and with refractive contents. **Hyphal pegs** absent. **Lamellar trama** broad, irregular, radially constructed, dimitic; skeletal hyphae predominant, 2-4.5 µm wide, with a wall up to 2 µm thick, rarely branched; generative hyphae, 3-6 µm wide, thin- to slightly (< 0.5 µm) thick-walled, branched, with clamp-connections, inamyloid. **Pileal trama** made up of dimitic hyphal system; generative hyphae dominant, 2-5 µm wide, sometimes inflated up to 12 µm, thin- to slightly (< 1 µm) thick-walled, highly branched and with prominent clamp-connections; skeletal hyphae 2-5 µm wide, rarely branched, with a wall up to 1.5 µm thick and a narrow lumen. **Pileipellis** a disrupted trichodermium of erect or ascending, 3-4 µm wide, cylindric terminal elements with obtuse apices, reaching up to 130 µm in length, projecting from hyaline to pale grey coloured, thin- to slightly (< 1 µm) thick-walled generative hyphae with abundant clamp-connections. **Stipitipellis** a trichodermium similar to the pileipellis in composition but the terminal elements often tend to form small, loose aggregations.

Habitat: On dead roots and rhizomes of bamboo [*Bambusa bambos* (L.) Voss], solitary or in caespitose clusters.

Decay type: White rot.

Known distribution: Known only from the type locality

COLLECTIONS EXAMINED — INDIA, KERALA STATE, Malappuram District, CALICUT UNIVERSITY CAMPUS: 2 July 2004, Arun Kumar AK61a (L); 5 July 2004, Arun

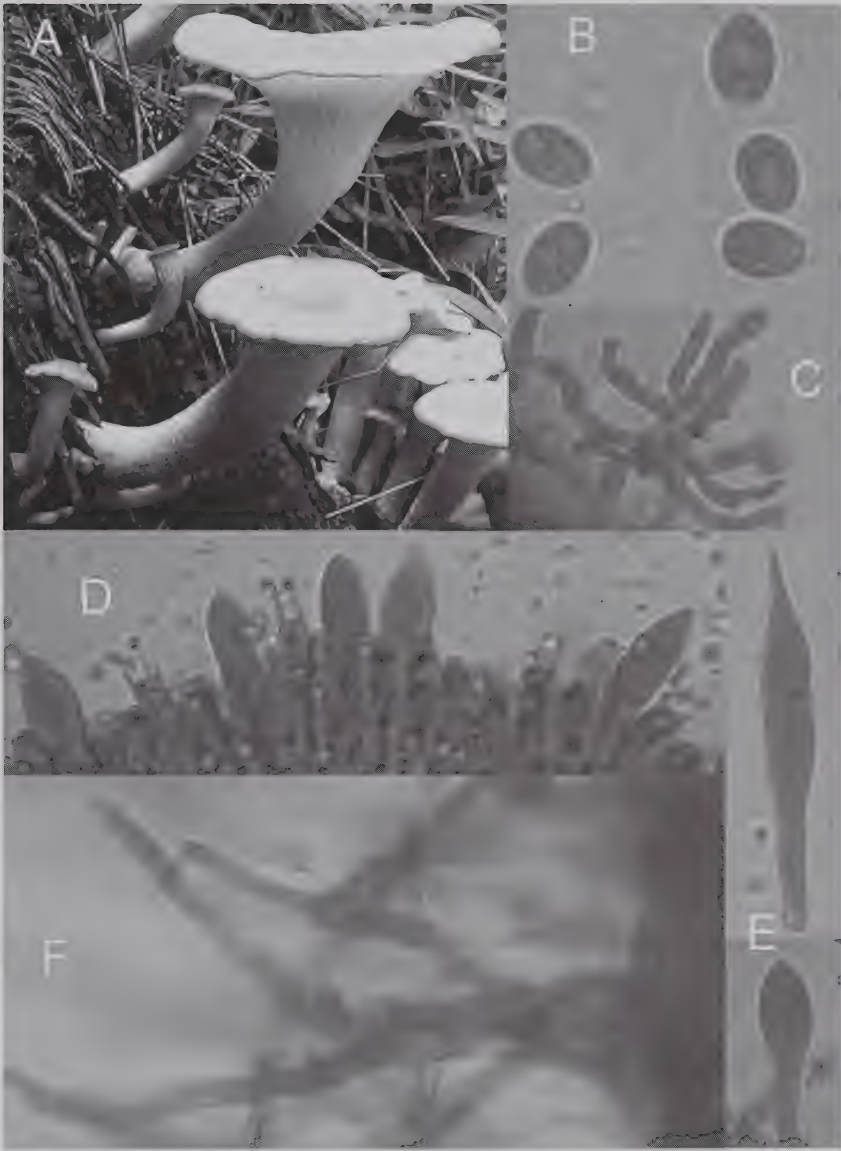


Fig. 1. *Lentinus bambusinus*: A, young basidiomata attached to bamboo roots, x 1; B, spores, x 1800; C, cheilocystidia, x 350; D, hymenium with projecting gloeocystidia, x 1000; E, gloeocystidia, x 750; F, pileipellis, x 1000.

Kumar AK61b (**holotype**) (L); 18 October 2004, Arun Kumar AK61c; 20 October 2004, Arun Kumar AK61d; 26 October 2004, Arun Kumar AK61e (the last three collections are maintained in the personal herbarium of P. Manimohan).

Discussion

Lentinus bambusinus is characterized by graminicolous basidiomata; sulcate-striate pileus; radially constructed lamellar trama; dimitic hyphal system consisting of sparingly branched skeletal hyphae and mostly non-inflated generative hyphae; ovo-ellipsoid spores; abundance of refractive gloeocystidia; trichodermial pileipellis and stiptipellis; and absence of both hyphal pegs and skeleto-ligative hyphae. Owing to this combination of features, it belongs to the section *Panus* of the subgenus *Panus* where it seems to be closely related to *L. caespiticola* Pat. & Har., which also, according to Pegler (1983), is always confined to dead grass roots and stems. In fact, the size and shape of the spores are remarkably similar in both these species. *Lentinus caespiticola* var. *asiaticus* Manim. & Leelav. is already known from the type locality of *L. bambusinus* (Manimohan & Leelavathy 1995). Examination of the holotype specimens and several other collections of *L. caespiticola* var. *asiaticus* (maintained at K) as well as the holotype specimens of *L. caespiticola* var. *caespiticola* (maintained at PC), however, revealed that there are several differences between *L. bambusinus* and *L. caespiticola* which are summarized below.

<i>L. bambusinus</i>	<i>L. caespiticola</i>
Basidiomata occurring on dead roots and bamboo rhizomes	Basidiomata occurring on dead roots and herbaceous grass stems
Basidiomata very large. Pileus ≤ 20 cm	Basidiomata small. Pileus ≤ 3 cm.
Mature pileal surface sulcate-striate	Mature pileal surface not striate
Lamellae ≤ 13 mm wide	Lamellae ≤ 2 mm wide
Gloeocystidia on lamellar sides & edges often morphologically different	Gloeocystidia on lamellar sides & edges morphologically similar
Pileipellis and stiptipellis distinctly trichodermial.	Pileipellis and stiptipellis $\pm$ undifferentiated with repent hyphae; semi-erect fascicles only rare

Although presently we follow Pegler's (1983) concept of the genus *Lentinus*, recent studies (e.g., Redhead & Ginns 1985; Hibbett & Vilgalys 1993; Hibbett & Thorn 1994; Hibbett et al. 1993) indicate that *Lentinus* sensu Pegler is polyphyletic. The *Panus-Pleurotus-Lentinus* complex seems to be composed of four monophyletic genera: *Lentinus* Fr., *Panus* Fr., *Pleurotus* (Fr.) Quel., and *Neolentinus* Redhead & Ginns (Rune 1994; Hibbett et al. 1994). At the moment we are not sure where the present species will eventually be placed when the dust settles in the taxonomy of this complex. *Lentinus* s. str. is ruled out as it is characterized by binding hyphae and hyphal pegs which this species lacks. The white rot produced by this species makes a relationship with *Neolentinus* (including *Heliocybe* Redhead & Ginns) unlikely. Aerial hyphae of cultures of this species grown on water agar failed to produce droplets of toxin on stalked secretory processes which, according to Hibbett & Thorn (1994), species of *Pleurotus* s. str. characteristically employ to capture nematodes. The skeletal hyphae,

the radial trama, and the purplish pigment of the young basidiomata indicate *Panus* s. str. but there are no metuloids and the gloeocystidia are an odd feature.

As *L. bambusinus* is known only from collections from a single locality, it is difficult to establish its relationship with bamboo. However, circumstantial evidences are compelling to assume some affinity of this agaric for dead bamboo roots. The collections of *L. bambusinus* were made from the base of a huge stand of bamboo that died in the previous year after flowering. Several basidiomata of *L. bambusinus* were observed around the base of this stand either as scattered specimens or in dense caespitose clusters always attached to the dead bamboo roots but never attached to other organic debris in that area including roots of adjacent living stands of bamboo. A one-meter deep trench recently made for cable-laying had exposed deeply buried roots of the dead bamboo stand. Remarkably, the dead bamboo roots located even at that depth produced basidiomata of *L. bambusinus*, when exposed, indicating systemic infection of the root system prior to the formation of basidiomata.

Acknowledgements

We are grateful to Dr D.S. Hibbett and Dr G.M. Mueller for presubmittal review of the manuscript. One of us (PM) thanks the Curator of Herb. PC for a loan of the holotype of *L. caespiticola*.

References

- Hibbett DS, Thorn RG. (1994). Nematode-trapping in *Pleurotus tuberregium*. *Mycologia* 86(5): 696-699.
- Hibbett DS, Vilgalys, R. (1993). Phylogenetic relationships of *Lentinus* (Basidiomycotina) inferred from molecular and morphological characters. *Systematic Botany* 18: 409-433.
- Hibbett DS, Murakami S, Tsuneda, A. (1993). Sporocarp ontogeny in *Panus*: evolution and classification. *American Journal of Botany* 80: 1336-1348.
- Hibbett DS, Murakami S, Tsuneda, A. (1994). Postmeiotic nuclear behavior in *Lentinus*, *Panus*, and *Neolentinus*. *Mycologia* 86(6): 725-732.
- Kornerup A, Wanscher JH. (1978). *Methuen Handbook of Colour*, 3rd Edn. Methuen: London.
- Manimohan P, Leelavathy KM. (1995). A new variety of *Lentinus caespiticola* from southern India. *Mycological Research* 99: 451-452.
- Manimohan P, Divya N, Kumar TKA, Vrinda KB, and Pradeep CK. (2004). The genus *Lentinus* in Kerala State, India. *Mycotaxon* 90(2): 311-318.
- Pegler DN. (1983). The genus *Lentinus*. A world monograph. *Kew Bulletin Additional Series* 10: 1-281.
- Redhead SA, Ginns JH. (1985). A reappraisal of agaric genera associated with brown rots of wood. *Transactions of the Mycological Society of Japan* 26: 349-381.
- Rune F. (1994). *Neolentinus* - a well-founded genus in *Pleurotaceae* that includes *Heliocybe*. *Mycological Research* 98: 542-544.

Morphology and taxonomy of the European species in *Lactarius* sect. *Deliciosi* (Russulales)

JORINDE NUYTINCK & ANNEMIEKE VERBEKEN

zorinde.nuytinck@ugent.be

Ghent University, Department of Biology, Research Group Mycology
K.L. Ledeganckstraat 35, B – 9000 Ghent Belgium

Abstract—Elaborate macro- and micromorphological descriptions are presented for the representatives of *Lactarius* sect. *Deliciosi*, together with taxonomical and nomenclatural remarks, partly based on previous molecular phylogenetic analyses (Nuytinck & Verbeken 2003 & 2005). Ten accepted European species are treated and an identification key is provided. Lectotypes are designated for *L. sanguifluus*, *L. semisanguifluus* and *L. vinosus*.

Key words—*Lactarius* sect. *Dapetes*, *L. porninsis*, systematics

Introduction

This paper deals with the European species in *Lactarius* sect. *Deliciosi* (Fr.: Fr.) Redeuilh, Verbeken & Walley (syn. sect. *Dapetes* (Fr. ex J. Kickx f.) Burl.) and is part of an extensive study of this group of striking milk caps. Most representatives of *Lactarius* sect. *Deliciosi* are popular species, which are highly appreciated for their culinary qualities, mainly in southern and eastern Europe. All but one species in this section are easily recognisable by their orange or red to blue coloured latex, caused by the presence of guaiane sesquiterpenes (Schmitt 1974, Bergendorff & Sterner 1988). Because of the variability of the colours and colour changes, not all current authors share the same species concepts, and 41 names are available for this limited number of European species. It is also this high variability of some important macroscopical characters used for identification (e.g. the colour and zonation of the cap and the discolouration of the latex) that leads to common misidentifications. Fresh collections in good condition are needed, preferably together with ecological data (host tree species, soil acidity), to achieve a reliable field determination. A detailed molecular approach to the species delimitations and phylogenetic relationships for this section is presented in Nuytinck & Verbeken (2003 & 2005). All commonly recognized European species (Basso 1999a, Bon 1980, Courtecuisse & Duhem 1994, Heilmann-Clausen et al. 1998) were confirmed by analyses based on morphological and molecular characters. An unexpected result was the inclusion of *L. porninsis* Rolland, traditionally classified in *Lactarius* sect. *Zonarii* (Quél.) Bon (nom. inval.). In addition, we concluded that *L. deterrimus* Gröger and *L. fennoscandicus* Verbeken & Vesterh. on the one hand, and *L. sanguifluus* (Paulet) Fr. and *L. vinosus* (Quél.→) Bataille on the other hand, are

very closely related and recently speciated taxa. In some cases, and this is true for nearly all species in this section, intermediate forms may strongly complicate correct identification. This review starts with a key to the species and includes a macro- and microscopical and ecological description for every species, together with a discussion on the taxonomy and nomenclature. A list of insufficiently known and doubtful names is given at the end.

Materials & Methods

This study is based on herbarium material deposited in BR, GENT, LIP, MPU, PC and the personal herbaria of P.A. Moreau and M. Contu.

Macroscopical characters are based on fresh material. Colour codes are from Kornerup & Wanscher (1962). Microscopic measurements and drawings were made under oil immersion at 1000× with a Zeiss Axioscop 2 microscope and drawing tube. All observations and measurements (except for the spores) were made in Congo red in L_4 (7.2 g KOH, 160 ml glycerine, 840 ml dH_2O , 7.6 g NaCl and 5 ml Invadin (Ciba-Geigi), Cléménçon, 1972). Where necessary a short pretreatment in 10% KOH was used to rehydrate the tissue. Basidia lengths exclude sterigmata lengths. We use the term cheiloleptocystidia for the thin-walled, mostly clavate to irregularly shaped cystidia, without specific content and with a rounded apex on the lamella edge. Observations and measurements of basidiospores were made in Melzer's reagent. Spores were measured in side view, excluding ornamentation and the measurements are given as (MIN) [Ava-2×SDa] – Ava – Avb – [Avb+2×SDB] (MAX) in which Ava = lowest mean value for the measured collections, Avb = greatest mean value and SDa/b = standard deviation of the lowest and greatest mean value respectively. MIN is the lowest value measured, MAX the highest value; MIN and MAX are only given when they exceed [Ava-2×SDa] or [Avb+2×SDB] respectively. Q stands for 'quotient length/width' and is given as MINQ – Qa – Qb – MAXQ in which Qa and Qb stand for the lowest and the highest mean quotient for the measured specimens respectively. MINQ/MAXQ stands for the minimum/maximum value over the quotients of all available measured spores. 20 spores were measured per collection.

Key to the European species of *Lactarius* sect. *Deliciosi*

Keep in mind that very small fruiting bodies and buttons are often entirely deep blue-green, regardless of the species (phenomenon observed in *L. salmonicolor*; *L. deliciosus*, *L. quieticolor* and *L. deterrimus*).

1. - Latex white; species growing with *Larix*. **5. *L. porninsis***
 - Latex orange, red or blue; species growing with other coniferous trees. 2
2. - Pileus entirely salmon orange, sometimes with a paler margin, without green tinges; green tinges seldomly present in very young or very old basidiocarps; species associated with *Abies*; pleuromacrocystidia very abundant and large (up to 96 µm long). **7. *L. salmonicolor***
 - Pileus mostly not purely orange but with green, blue, brownish, greyish or red tinges; discolouring green when bruised or when older; species associated with *Pinus* or *Picea*; pleuromacrocystidia max. 70 µm long, often quite rare. 3

3. - Latex blue in the major part of the fruiting body but orange in the lower half of the stipe; stipe with clear blue tinges; species restricted to the mediterranean region; associated with *Pinus halepensis*. **1. *L. cyanopus***
- Latex orange or red, rarely with a bluish or greenish zone right underneath the pileipellis; stipe mainly orange, reddish or with green tinges; not restricted to the mediterranean region; associated with *Pinus* or *Picea*. 4
4. - Latex red when exuded; lamellae pinkish to vinaceous red; associated with *Pinus*. 5
- Latex orange when exuded; lamellae orange; associated with *Pinus* or *Picea*. 6
5. - Pileus and stipe with orange tinges; pileus generally azonate; pileus slowly and relatively slightly discolouring greenish; stipe cylindrical or rarely tapering downwards; lamellae pinkish. **8. *L. sanguifluus***
- Pileus and stipe with pale to deep vinaceous red tinges; pileus generally clearly zonate; pileus strongly discolouring greenish after picking the basidiocarps; stipe mostly short and strongly tapering downwards; lamellae pale violet to vinaceous. **10. *L. vinosus***
6. - Orange latex becoming quickly vinaceous red (in 5 to 8 min.); often with a lot of green in pileus, especially in older specimens. **9. *L. semisanguifluus***
- Latex remaining orange for more than 10–15 min.; some green may be present in the pileus, especially in bruised spots, but basidiocarp never entirely greenish . . 7
7. - Stipe without (obvious) scrobicules; species associated with *Picea*; spore ornamentation consisting of isolated warts and short ridges, never reticulate. . . 8
- Stipe mostly with scrobicules; species associated with *Pinus*; spores ornamented with an incomplete reticulum. 9
8. - Pileus typically azonate or with a few zones near the margin, with mainly bright orange colours and green tinges; stipe unicolourous bright orange without scrobicules but often with green hues; cheilomacrocystidia mostly quite abundant; species common everywhere in Europe. **3. *L. deterrimus***
- Pileus very clearly zonate and brown-orange with sometimes lilac-grey tinges; stipe pallid to dull orange-buff, rarely with unclear scrobicules; cheilomacrocystidia mostly rare; a subboreal, boreal and subalpine species. . . . **4. *L. fennoscandicus***
9. - Latex orange, remaining orange or changing slowly to red in more than 30 min.; pileus orange, mostly with a whitish aspect, mostly clearly zonate; stipe clearly scrobiculate; species occurring on neutral to calcareous soil; spores not very heavily ornamented. **2. *L. deliciosus***
- Latex orange, changing to red in about 20 min.; pileus colour highly variable, from orange to brownish and sometimes bluish, but mostly dull; stipe almost without or with inconspicuous scrobicules; species growing on acidic soil; spores ornamented with very thick ridges. **6. *L. quieticolor***

Descriptions and taxonomical conclusions

1. *Lactarius cyanopus* Basso, Bull. Trimestriel Soc. Mycol. France 114: 67 (1998)

Fig. 1

Holotype: 8630 (LUG), Italy: Liguria, Imperia, Civezza.

DESCRIPTION (after Basso 1999b): *Pileus* 3–8 (12) cm diam., plano-convex with a slightly inrolled margin when young, flattened to funnel-shaped when full-grown, margin only slightly bent downwards or sometimes almost straight, regularly shaped, especially when young, to wavy, lobed or gibbous, margin thin and smooth; surface smooth, sticky and even slightly viscid when humid; colour pale ivory blue, with orange and blue shades or even almost entirely pale blue when young, more rarely with more or less regular, darker zones, sometimes with scarce, greenish to ochre-blue or clear blue-green spots, in age becoming creamy blue, creamy green, pale creamy ochre and washed-out to whitish. *Lamellae* subdecurrent to decurrent, medium dense, thin in young and thicker in older specimens, sometimes forking near the stipe, very fragile; colour pale cream to pale creamy orange but always with blue-green tones, becoming creamy green, sometimes even pale green with almost no cream shade, becoming bluish and then bluish green when bruised; edge entire, concolorous. *Stipe* 1.7–5 × 0.9–2.1 cm, short in relation to pileus diameter, subcylindric or slightly broader to more narrow at the base, full and firm when young but soon hollow; surface slightly irregular because of the presence of dimples, small humps or more rarely small scrobicules that are hardly any darker than the rest of the surface; colour white to whitish blue and pruinose in the zone of contact with the lamellae, whitish blue, blue to intense greenish blue with age in the upper part, paler, creamy blue centrally and white with ochre spots at the base. *Context* thin but rather firm when young, then becoming a little elastic, whitish in the pileus and underneath the pileipellis, white with a bluish tone in the central part of the stipe, sometimes with faint ochre or violet tones, blue to bluish above the lamellae and underneath the stipitipellis halfway down the stipe or sometimes right down to the base, becoming progressively dark blue-green, orange, becoming red and finally greenish in the lower half of the stipe or only at the base; smell indistinct, fruity, resembling the smell of much of the other species in the section, taste pleasant, mild, absolutely not acrid nor bitter, even after chewing for a long time. *Latex* very scarce, orange in the base of the stipe, changing to red but blue or bluish in the rest of the stipe and in the cap; taste mild. *Spore deposit* unknown.

KOH slowly turning brown-grey, *gaiac* no reaction.

Spores 6.9–8.3–8.8–9.7 (9.9) × 5.8–6.8–7.1–7.8 µm, subglobose to ellipsoid but generally broadly ellipsoid ($Q = 1.12\text{--}1.22\text{--}1.24\text{--}1.34$); ornamentation rather low (< 0.5 µm), of rather thin and slender ridges, often angular, forming mostly a complete network, isolated warts rare to absent; plage non-amyloid. *Basidia* 49–67 × 9–12 µm, subclavate, 4-spored, content sometimes granular or with oil droplets; sterigmata 4.5–7.5 µm long. *Pleuromacrocystidia* abundant, 38.5–70 × 5.5–8.5 µm, emergent, subcylindric to subfusiform with an obtuse to mostly moniliform apex, sometimes with a branching apex, often containing small, needle-shaped crystals, thin-walled. *Pseudocystidia* relatively rare, not or rarely emergent, cylindrical to tortuous, slender (2–5.5 µm broad), with a rounded apex, content similar to the lactifers but hyaline in the apex. *Lamella edge* sterile with abundant cheilomacrocystidia; cheileleptocystidia

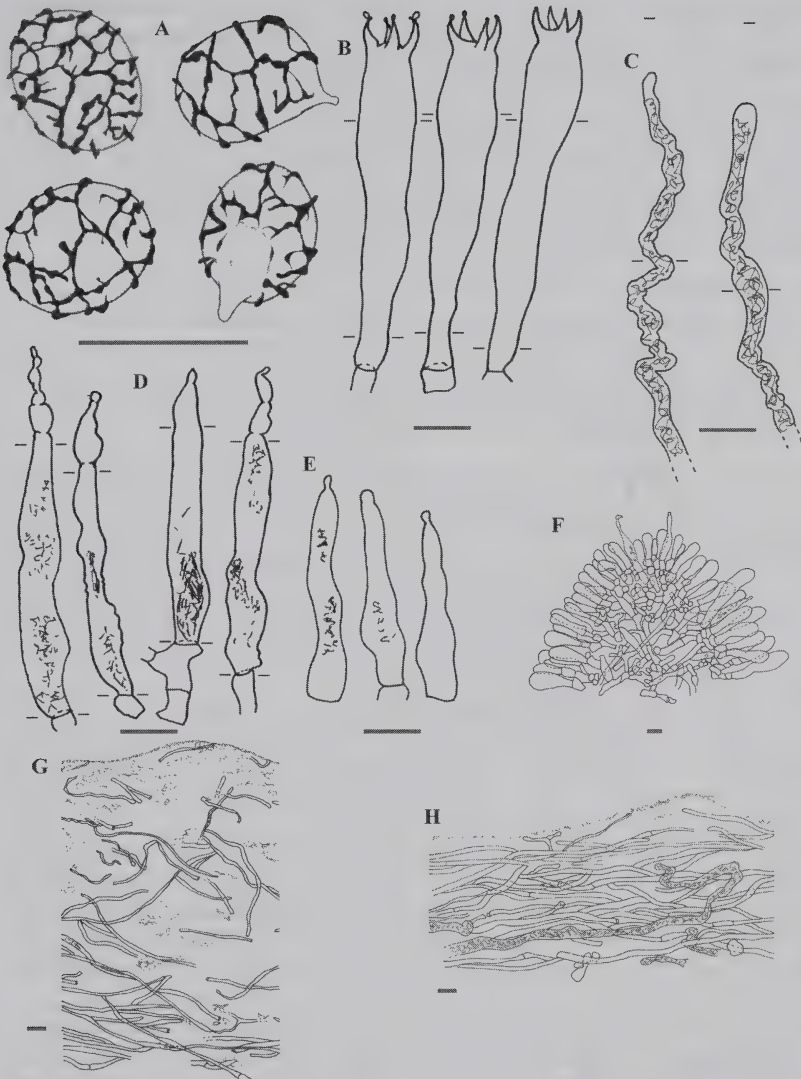


Fig. 1: *Lactarius cyanopus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. lamella edge; G. section through the pileipellis; H. section through the stiptipellis. From M.T. Basso 98102204 and M.T. Basso 98103001. Scale bars = 10 μm , small bars indicate the height of the hymenium.

11–28 $\times$ 3–9.5 μm , short and rounded to longer and cylindrical, hyaline, thin-walled; cheilomacrocystidia 29–42 $\times$ 6–8 μm , subfusiform, often with a moniliform apex, content needle-like, thin-walled. *Subhymenium* composed of globose to more angular cells, more or less arranged in rows. *Hymenophoral trama* irregularly filamentous; with

rather abundant but slender lactifers. *Pileipellis* an ixocutis, up to 200 µm thick, slime-layer thin, of thin-walled, frequently branching and strongly interwoven hyphae, 2–5 µm diam., some are gelatinised or shrivelled. *Stipitipellis* a cutis to ixocutis, 50–120 µm thick, slime-layer thin where present, of thin-walled, interwoven hyphae, 2–3.5 µm diam., few hyphae gelatinised, some hyphae shrivelled, lactifers numerous and close to the surface, 3–10 µm diam. *Clamp-connections* absent.

HABITAT: Associated with *Pinus halepensis*; in mediterranean carigue vegetation with *Cistus albidus*, *Spartium junceum* and *Thymus vulgaris* (type locality, Basso 1999b); calcareous soil (Pérez-De-Gregorio & Carbó 2004).

DISTRIBUTION: Reported from Spain and Italy.

COLLECTIONS EXAMINED: **Italy**, Civezza (Imperia), road to Monte Faudo (type locality), 320 m a.s.l., *Cistus albidus* with *Pinus halepensis*, 22.10.1998, M.T. Basso 98102204 (GENT) – *ibid.*, 30.10.1998, M.T. Basso 98103001 (GENT) – **Spain**, Girona, Baix Empordà, Vall-llobrega, 100 m a.s.l., under *Pinus halepensis*, on calcareous soil, 18.11.2002, M.A. Pérez-De-Gregorio 181102 (GENT).

DISCUSSION: *L. cyanopus* was described in 1998 and is reported from three localities: Civezza (Imperia, Italy: type locality; Basso 1998), Vall-llobrega (close to Girona, Spain) and Mallorca (Pérez-De-Gregorio & Carbó 2004). A forest fire destroyed the type locality in 2000 (Basso, pers. comm.), making it impossible for us to study fresh specimens. The macroscopical description given here is a summary of the description by Basso (1999b). In this original description, *Cistus* is stated erroneously as the host species for *L. cyanopus*. *Pinus halepensis* grows nearby and is almost certainly the host tree (Basso, pers. comm.).

The extensive blue colours in the cap and stipe in *L. cyanopus* are unique in Europe. Young specimens of *L. quieticolor* can also be strikingly blue to bluish green in the pileus (Heilmann-Clausen et al. 1998). Microscopically however, *L. cyanopus* is very different from *L. quieticolor*: the spore ornamentation in particular is much heavier in *L. quieticolor*.

The spore ornamentation in *L. cyanopus* is peculiar in that it often forms a complete network, which is rare in the other European *Deliciosi*. This very complete network was not observed in the Spanish collection however. *L. sanguifluus* has smaller and more rounded spores with thicker ridges forming an incomplete network. The profile of the spores of *L. semisanguifluus* is similar to the *L. cyanopus* spores but the ornamentation is more incomplete, isolated warts are more abundant.

According to our molecular analyses, *L. cyanopus* belongs to the same clade as *L. sanguifluus* and *L. vinosus* or even falls within *L. sanguifluus* and would thus be conspecific (Nuytinck & Verbeken 2005). However, we do not synonymise both names here. The very poor state of the *L. cyanopus* specimens made it hard to extract good quality DNA and several attempts were needed to amplify the ITS region. From a morphological point of view it seems very unlikely that both are conspecific. Most importantly because of differences in the spore ornamentation and spore shape, but also because *L. cyanopus* has orange coloured latex in the lower half of the stipe. *L. sanguifluus* has vinaceous red latex and only very exceptionally some orange latex in the very base of the stipe or where the mycelium is attached has been observed (never halfway up the stipe, Romagnesi 1958). Unfortunately the original description of *L.*

cyanopus does not state clearly how quickly this orange latex in the base of the stipe turns reddish (maybe because of the bad state of the specimens?).

2. *Lactarius deliciosus* (L.: Fr.) Gray, Nat. Arr. Br. Pl. 1: 624 (1821)

Fig. 2

- Basionym: = *Agaricus deliciosus* L., Species Pl.: 1172 (1753)
 Synonyms: = *Lactaria lateritia* Pers., Tent. Disp. Meth. Fung.: 64 (1797)
 = *L. deliciosus* var. *lamelliporus* (Barla) Sacc., Sylloge Fungorum 5: 438 (1887)
 = *Agaricus deliciosus* var. *lamelliporus* Barla, Champ. Prov. Nice: 35 (1859)
 = *L. deliciosus* var. *pini* Vassilkov, [Edible and poisonous fungi of central parts Europ.distr. U.S.S.R.]: 60 (1948), nom. inval., nom. nud.
 = *L. pinicola* Smotl. ex. Z. Schaef., Schweiz. Z. Pilzk. 48: 141 (1970)
 = *L. deliciosus* var. *pinicola* Smotl., Atlas hub jedlých a nejedlých [Atlas of edible and inedible fungi]: 219 (1947), nom. inval., nom. nud.
 = *L. deliciosus* f. *rubescens* J.A. Schmitt, Z. Pilzk. 39: 238 (1974)
 = *L. deliciosus* var. *lateritius* J. Blum ex J. Blum, Lactaires: 216 (1976)
 Excluded: *L. deliciosus* ss. Lange (1940) and many earlier authors from central and eastern Europe (= *L. deterrimus*)

Type: not selected, described from southern Sweden.

DESCRIPTION: *Pileus* 4–12 cm diam., sometimes larger, convex with an inrolled margin and a slightly depressed centre at first, later with a decurved to expanded margin and with a depressed centre to infundibuliform, sometimes $\pm$ irregularly shaped; surface viscid but soon dry, $\pm$ smooth; colour pale orange (5A2/4) to salmon orange (6A4/5), typically with a whitish aspect (a white bloom), with deeper orange (6B7/8) spots of irregular shape, sometimes forming a few broad, concentric zones, towards margin often with narrow zones, discolouring reddish and then greenish where bruised, but not very extensively. *Lamellae* slightly decurrent to decurrent, rather narrow to medium broad, rather crowded, often forking near the stipe; colour salmon to yellowish orange (5A6/7 to 6A/B7), discolouring red and then green where bruised; edge slightly paler, entire. *Stipe* 2.5–5 $\times$ 1–3 cm, typically relatively short and chunky, almost cylindrical or slightly tapering downwards; surface dry; colour orange with a well developed whitish surface layer (6A4/5), almost white at the very top, with a few to numerous, small to large, deeper orange scrobicules (6A/B8) (scrobicules only very rarely absent), greenish where bruised. *Context* firm, with an irregular cavity in the stipe, white to pale cream in the central parts, bright orange just above the lamellae, underneath the pileipellis and near the stipe surface (5/6A8), orange parts remaining orange (orange often slowly fading) or very slowly turning brownish orange to orange-red (7B/C7/8, after 30 min. to 1 h), greenish after several hours; smell fruity; taste mild to very slightly acrid at first and then slightly bitter. *Latex* scarce, bright orange (5/6A8), often very slowly changing to red on the context; taste mild. *Spore deposit* pale yellow-orange (4A3).

FeSO₄ no reaction, *KOH* no reaction, *phenol* no reaction, *gaiac* very slowly turning blue on context, *HCl* no reaction.

Spores 6.5–8.1–9.7–10.6 $\times$ 5.4–6.2–7.0–7.7 μ m, broadly ellipsoid to ellipsoid, rarely subglobose ($Q = 1.10$ – 1.25 – 1.39 – 1.50); ornamentation up to 0.5 μ m high, of rather thick and broad ridges, forming a coarse, incomplete to almost complete reticulum, with some short ridges and isolated warts present; ridges rarely less amyloid at the top, giving them a split appearance; plage mostly slightly amyloid distally, often with some

small amyloid spots centrally. *Basidia* 43–65 × 9.5–12 µm, ± cylindrical to subclavate, 4-spored, sometimes with oil-droplets; sterigmata 4–6 µm long. *Pleuromacrocyttidia* (very) scarce but more abundant near the lamella edge, 34–55 × 6.5–9 µm, slightly emergent, subfusiform, with a narrowing, obtuse or moniliform apex, often with a needle-like content, thin-walled. *Pseudocystidia* rather abundant, 2–6 µm diam., mostly not emergent, often branching and irregularly shaped, content similar to the lactifers but often hyaline in the apex. *Lamella edge* sterile (or rarely with a few basidia) with (very) abundant cheilomacrocyttidia; cheileptocystidia 8–25 × 3–10 µm, subclavate to irregularly shaped, hyaline, thin-walled; cheilomacrocyttidia 30–40 × 5–7 µm, subfusiform to fusiform, with a moniliform apex, with a needle-shaped content, thin-walled. *Subhymenium* appearing like short, irregularly shaped cells, often in rows. *Hymenophoral trama* irregularly filamentous; abundant lactifers present with an ochre content. *Pileipellis* an ixocutis, up to 200 µm thick, with a very thin slime-layer, composed of thin-walled, frequently branching hyphae, 2–7 µm diam.; few hyphae gelatinised or very narrow (1–2 µm diam.), most hyphae with slightly refringent walls and larger diam., some with short knot-like branches. *Stipitipellis* a cutis, up to 150 µm thick, of thin-walled hyphae, 2–4 µm diam.; emergent hyphae frequent, giving sometimes the impression of a trichoderm; emergent hyphae absent where scrobicules occur. *Clamp-connections* absent.

HABITAT: On neutral to calcareous soils, forming ectomycorrhizae with *Pinus* species (Uhl 1988).

DISTRIBUTION: Widespread in Europe, also found in Turkey and Morocco, but certainly not the most common species in central and eastern Europe. Reported from all over the world, with indigenous and introduced *Pinus* spp., identifications often doubtful (Nuytinck et al. in preparation)

COLLECTIONS EXAMINED: **Austria**, Nordtirol, Vomperberg, 900 m NN, 23.10.1993, leg. & det. Plenk, KR 164/93 (GENT) – **Belgium**, Westerloo, 1.11.1937, M. Herregods 188 (GENT) – West-Vlaanderen, De Haan, close to *Pinus*, in sand dunes, 1.11.1984, I. Cauwels 84-36 (GENT) – Oostvoordeduin, Under *Pinus* at graveyard, 22.10.1993, A. Verbeken 93-133 (GENT) – Nîmes, J5.41.14, *Pinus sylvestris*, border limestone grassland, 30.09.1995, R. Walley 0378 (GENT) – Zedelgem, Vloethemveld, C1.47.22, in grassy, nutrient-poor roadside (close to *Pinus sylvestris*), 20.10.2002, R. Walley 2784 (GENT) – Close to Ave-et-Auffe, 244 m a.s.l., N50°07.060' E005°08.025', under *Pinus*, 26.10.2003, J. Nuytinck 2003-047 (GENT) – **Denmark**, NEJ: Høstemark Skov S of Mou, UTM NJ7511, TBU 11, under *Pinus*, 1.10.1995, J. Vesterholt 95-482 (GENT) – NEJ: Læsø, Estrupvej, SW of Vesterø Havn, UTM PJ1549 TBU 03, at roadside under *Pinus*, 16.10.1996, Vesterholt 96-312 (GENT) – **Finland**, road from Riikinranta to Sotkamo, spruce and pine forest, 6.09.2001, J. Nuytinck 2001-036 (GENT) – **France**, Dept. Tours, under *Pinus*, 28.10.1991, R. Walley 0378 (GENT) – Forêt Domaniale de Fontaineau, Hippodrome La Solle, under *Pinus* on calcareous, dry, sandy soil, in grassy vegetation, 4.10.2001, leg. P.-J. Keizer, J. Nuytinck 2001-129 (GENT) – **Germany**, Baden-Württemberg, Deufringen, Mesobromethum auf Muschelkalk, under *Pinus*, 27.10.1988, H. Haas 4000430 (GENT) – Baden-Württemberg, Stuttgart-Weilimdorf, Neuer Friedhof, 340m, 7120/4.34, 23.09.1989, Bollmann A., KR 566/91 (GENT), as *Lactarius deliciosus* f. *rubescens* – Baden-Württemberg, Schaffhausen, MTB 7219/3.23, Wacholderheide auf Muschelkalk, under *Pinus sylvestris* and *Juniperus communis*, 28.10.2001, A. Gminder (GENT) – **Italy**, Toscana, Cala Violina NW of Grosseto,

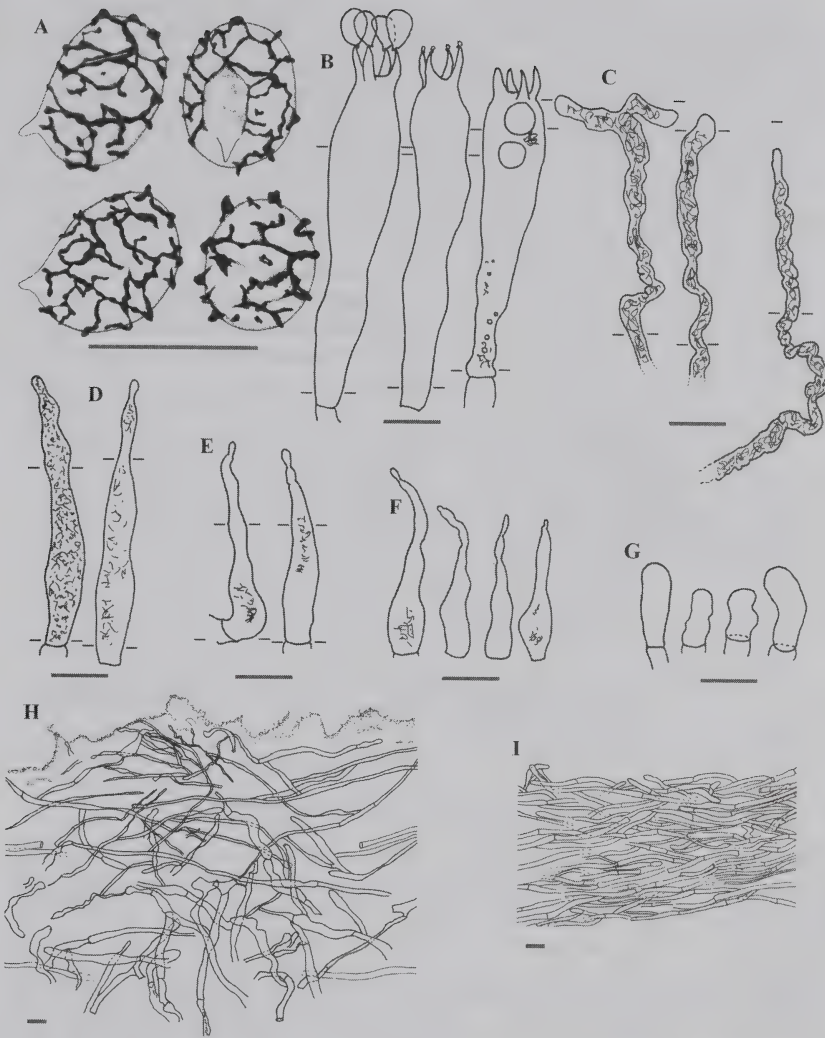


Fig. 2: *Lactarius deliciosus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocyistidia; E. macrocyistidia close to the lamella edge; F. cheilomacrocyistidia; G. cheileleptocystidia; H. section through the pileipellis; I. section through the stipeipellis. From A. Peksen & G. Hatat 229, J. Vesterholt 96-312 and J. Nuytinck 2001-006, 2001-036, 2001-101, 2001-117, 2002-042, 2003-057. Scale bars = 10 µm, small bars indicate the height of the hymenium.

under *Pinus*, 7.11.1996, leg. M. Christensen, J. Vesterholt 96-457 (GENT) – Sardegna, Tempio Pausania, road SS133, at about 2 km from centre, plateau (old vineyard?), soil rather calcareous, under *Pinus halepensis*, 1.11.2000, A. Verbeken 2000-104 (GENT) – Slovakia, Záhorská ěmžina lowland, 4 km SW of Moravský Svätý ĵan village, on the

river side of the Morava (W Slovakia, <1 km from Austrian border), 120-130 m a.s.l., N48°33.480' E016°56.978', *Pinus* forest on sand, under *Pinus sylvestris*, 2.10.2001, J. Nuytinck 2001-045 (GENT) – *ibid.*, 2.10.2001, J. Nuytinck 2001-046 (GENT) – Záhorská 'mžina lowland, 3 km NWW of Lakšárska Nová Ves village, 200m a.s.l., *Pinus sylvestris* plantation, 3.10.2001, J. Nuytinck 2001-052 (GENT) – Nízke Tatry mountains; 2,5 km N to Malužiná village, Michalovo valley, 707m a.s.l., N49°00.094' E019°45.470', In pasture on slope under *Pinus sylvestris*, calcareous soil, 6.10.2001, J. Nuytinck 2001-071 (GENT) – **Spain**, Surroundings of St Hilary Sacalm, 3.11.2001, bought on a local market, J. Nuytinck 2001-101 (GENT) – *ibid.*, 3.11.2001, bought on a local market, J. Nuytinck 2001-102 (GENT) – Between Coll Sacren and east-side of A7, Montenegro mountain, 6.11.2001, J. Nuytinck 2001-108 (GENT) – Close to Llorella del Mar, 134 m a.s.l., N41°45.032' E002.48.527', mediterranean vegetation with *Pinus* sp. and *Quercus ilex*, 8.11.2001, J. Nuytinck 2001-117 (GENT) – St Hilary Sacalm, 8.11.2001, J. Nuytinck 2001-118 (GENT) – Close to Fuenteheridos, region of Aracena, 690 m a.s.l., N37°54.195' W006°40.846', under *Pinus pinaster*, 4.11.2003, J. Nuytinck 2003-049 (GENT) – El Talenque, 587 m a.s.l., N37°55.749' W006°40.452', under *Pinus*, J. Nuytinck 2003-055 (GENT) – Between Linares de la Sierra and Alajar, 685m, N37°52.789' W006°38.792', under *Pinus pinea*, 7.11.2003, J. Nuytinck 2003-057 (GENT) – **Sweden**, Borgsjö, youth hostel, ±120 m a.s.l., N62°32.481' E015°54.049', grassy place, 12 m from closest *Pinus sylvestris* tree, 25.08.2001, J. Nuytinck 2001-005 (GENT) – *ibid.*, 25.08.2001, J. Nuytinck 2001-006 (GENT) – *ibid.*, 25.08.2001, J. Nuytinck 2001-007a (GENT) – *ibid.*, 25.08.2001, J. Nuytinck 2001-007b (GENT) – *ibid.*, 25.08.2001, J. Nuytinck 2001-007c (GENT) – City park in Ange, ±240 m a.s.l., N62°31.127' E015°39.574', lawn on small hill with *Pinus sylvestris* and *Betula*, 28.08.2001, J. Nuytinck 2001-016 (GENT) – Graveyard Bräcke, under *Pinus sylvestris*, 29.08.2001, leg. D. Laber, J. Nuytinck 2001-021 (GENT) – **Turkey**, Samsun region, under *Pinus*, 30.08.1997, A. Peksen & G. Hatat 104 (GENT) – Samsun region, under *Pinus*, 26.11.1997, A. Peksen & G. Hatat 229 (GENT) – Kocadağ, 682 m a.s.l., N41°19.279' E036°07.631', mainly *Pinus* forest on slope of hill, 22.10.2002, J. Nuytinck 2002-041 (GENT) – Kocadağ, 702 m a.s.l., N41°19.279' E036°07.545', mainly *Pinus* on slope, 22.10.2002, J. Nuytinck 2002-042 (GENT).

DISCUSSION: Several features are characteristic for *L. deliciosus*: the orange cap with the whitish zonate aspect, the scrobiculate, pale orange stipe, the bright orange latex staying orange on the context for more than 30 min. and often longer, the often large dimensions of the cap combined with a short and chunky stipe and the association with *Pinus*. The green discolouration is never very strong. Not all specimens have the combination of all of these features! Different weather and growing conditions make appearance of the pileus very variable. The spores are ornamented with rather thick ridges compared to most other species, but this difference is subtle, and best observed by comparison with reference specimens.

In his detailed study of specific guaiane sesquiterpenes colouring the latex in *Lactarius* sect. *Deliciosi*, Schmitt (1974) describes *L. deliciosus* f. *rubescens*. This form has reddening latex (after about one hour) while in the forma typica the latex is supposed to stay orange. Most authors describe *L. deliciosus* with unchanging, orange milk, fading after some time and eventually becoming greenish (Neuhoff 1956, Romagnesi 1958, Bon 1980). However, we observed a very slow colour change from orange to red in most *L. deliciosus* specimens. Basso (1999a) confirms this observation. Therefore, we do not consider *L. deliciosus* f. *rubescens* to have any taxonomical significance.

Some uncertainty exists about what Linnaeus (1753) and Fries (1821) actually meant by *L. deliciosus*. Both *L. deliciosus* and *L. deterrimus* are common in the Swedish forests, where *Pinus* and *Picea* often occur mixed. According to Schaefer (1970), *L. deliciosus* sensu Linnaeus and Fries is what we currently call *L. deterrimus* and he renamed the *Pinus* associated species *L. pinicola* Smotl. ex. Z. Schaefer. One of his main arguments was that Fries' expression "in pinetis" means growing under coniferous trees in general and he was strengthened in his opinion after studying table 6 in Fries (1861): the plate shows without doubt the *Picea* associated species. It seems very likely to us however, that *L. deliciosus* and *L. deterrimus* have not been considered to be separate species for a long time. According to Basso (1999a), Fries (1821 and later) refers to several other plates in his work that do represent the typical *L. deliciosus* (e.g. Schaeffer 1762–1774, Barla 1859, Krombholz 1831–1846). The plate of *L. deliciosus* that was painted in 1851 under the supervision of Fries also depicts *L. deliciosus* (plate number S0691, ÅG 06, by E. Pettersson, Strid 1994). There is a general consensus now to use the name *L. deliciosus* for the *Pinus* associated species. Designation of a neotype from the region where it was originally described will definitively settle this discussion.

Blum (1976) described *L. deliciosus* var. *lateritius*, with a brownish orange cap and clear greyish brown zonations, strongly resembling some *L. zonarius* or *L. torminosus* collections. This name is currently not widely used. No collection is available from PC with collection number 62.2 (number indicated by Blum as the type collection). Two of Blum's collections (PC 1644 & PC 1653), labeled as *L. deliciosus* var. *lateritius*, were examined instead. Microscopically they are identical to *L. deliciosus* and the synonymy of *L. deliciosus* var. *lateritius* as also proposed by Basso (1999a) is accepted here.

3. *Lactarius deterrimus* Gröger, Westfäl. Pilzbriefe 7: 10 (1968)

Fig. 3

Synonyms: = *L. deliciosus* var. *deterrimus* (Gröger) Hesler & A.H. Sm., N. Amer. Species *Lactarius*: 94 (1979)

= *L. deliciosus* var. *piceus* Smotl., Atlas hub jedlých a nejedlých [Atlas of edible and inedible fungi]: 218 (1947), nom. inval., nom. nud.

= *L. deliciosus* var. *piceae* Vassilkov, [Edible and poisonous fungi of central parts Europ. distr. U.S.S.R.]: 60 (1948), nom. inval., nom. nud.

Misapplications: *L. deliciosus* ss. Lange (1940) and many earlier authors from central and eastern Europe (see below)

L. semisanguifluus ss. Neuhoff (1956)

Holotype: DR (requested information on type number not received from DR), described from Germany: Krahnberg, near Gotha.

DESCRIPTION: *Pileus* 4–11 cm diam., typically convex when young, becoming slightly depressed to broadly infundibuliform, with a straight to slightly decurved margin when mature, sometimes staying convex, even when full-grown or old, mostly regularly shaped, margin smooth when young, becoming substriate when old; surface smooth, viscid and greasy when young but soon dry, azonate or sometimes with some zones, especially near the margin; colour rather variable, often (light) salmon orange (6A4/5) with darker zones (6C7) especially near the margin and a brownish orange centre (6D6), sometimes brighter orange (6A7), when dry often very pale orange (6A3, 5A3/5) and azonate, where bruised or when old turning (pale) greyish green, sometimes extensively. *Lamellae* broadly adnate to slightly decurrent, rather narrow to medium broad and rather

crowded, often forking or anastomosing near the stipe; colour (pale) orange (6A6 to 5B7 when old), quickly becoming red when bruised and then slowly turning green (after 1–2 h); edge entire and $\pm$ concolorous. *Stipe* 2–7.5 (10) $\times$ 0.8–2 (2.5) cm, mostly cylindrical, typically long and slender (in comparison with *L. deliciosus*); surface smooth and dry, scrobiculae almost always completely absent (when present small and scarce); colour bright, carrot orange (6A6/7 to 6B7/8), sometimes paler, turning green where bruised or after frost, typically with a white zone just underneath the lamellae. *Context* rather firm but thin in the pileus, especially near the margin, becoming hollow in stipe, white to buff, underneath pileipellis and stipitipellis and above the lamellae bright orange when cut (6A8), becoming red in (10) 15–20 min. (7/8B8), vinaceous red in 1 h (up to 10E6 but often paler) and green in 12 h; smell agreeable, fruity; taste mild but when chewing a large amount for a while becoming slightly acid and bitter. *Latex* bright orange (6A8) at first, becoming red after 15–20 min. when drying on the context; taste mild. *Spore deposit* pale yellow-orange (4A3).

FeSO₄ no reaction, *KOH* no reaction, *phenol* no reaction, *gaiac* slowly turning blue on context.

Spores 7.6–8.5–9.4–10.4 $\times$ 5.9–6.6–7.1–8.0 μ m, broadly ellipsoid to mostly ellipsoid ($Q = 1.25$ – 1.34 – 1.38 – 1.50); ornamentation up to 0.5 μ m high, of mainly warts and short, rather broad ridges with some interconnecting finer lines, forming a very incomplete reticulum; plage very faintly amyloid distally. *Basidia* 45–60 $\times$ 9.5–12 μ m, $\pm$ cylindrical to subclavate, 4-spored, with oil-droplets or a granular content; sterigmata 4.5–5.5 μ m long. *Pleuromacrocystidia* scarce but locally abundant near the lamella edge, 45–65 $\times$ 5–8 μ m, sometimes smaller near the lamella edge, emergent, subfusiform, with a narrowing or mostly moniliform apex, often with a fine, granular content, thin-walled. *Pseudocystidia* abundant, 4–6 μ m broad, sometimes emergent but often shorter than the basidioles, cylindrical to rather tortuous, with an ochre-yellow content similar to the lactifers but almost invisible near the apex. *Lamella edge* mostly sterile with few to rather abundant cheilomacrocystidia; cheileptocystidia 15–25 $\times$ 5–10 μ m, subclavate or irregular, hyaline or with a fine, granular content, thin-walled; cheilomacrocystidia 25–50 $\times$ 6–8 μ m, subfusiform with a moniliform apex, hyaline or with a granular content, thin-walled. *Subhymenium* composed of rather small, globose cells arranged in short rows to irregular. *Hymenophoral trama* irregularly filamentous; lactifers abundant and conspicuous with an ochre-yellow content. *Pileipellis* an ixocutis, up to 200 μ m thick; slime-layer relatively thick, of interwoven hyphae with a diam. of 1–4 (7) μ m and refringent walls; shrivelled and gelatinised hyphae abundant. *Stipitipellis* a cutis, up to 100 μ m thick, of interwoven hyphae with a diam. of 3–5 μ m, with very few shrivelled and gelatinised hyphae. *Clamp-connections* absent.

HABITAT: Forming ectomycorrhiza with *Picea* (Agerer 1986, Münzenberger et al. 1986) and often very common where the host tree occurs, on calcareous to neutral, often in young *Picea* plantations.

DISTRIBUTION: Widespread in Europe, extending eastwards to Russia (Vassilkov 1948), very common in northern, central and eastern Europe. Certainly more common than *L. deliciosus* in central Europe (Gröger 1968, Schaefer 1970).

COLLECTIONS EXAMINED: **Austria**, kleines Walsertal, Moos-Alpe, 21.09.1998, V. Walther 4006560 (GENT) – **Belgium**, Ravels, 26.11.1961, Verheyen K. 996 (GENT) – Nismes,

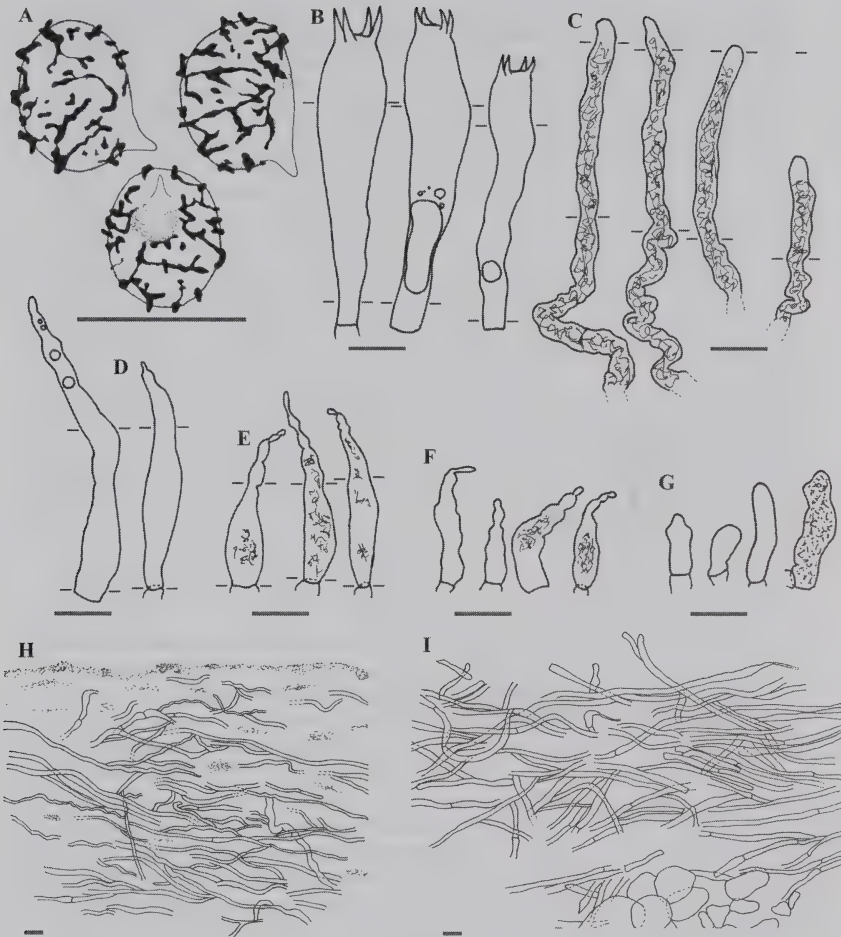


Fig. 3: *Lactarius deterrimus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. macrocystidia close to the lamella edge; F. cheilomacrocystidia; G. cheileleptocystidia; H. section through the pileipellis; I. section through the stipitipellis. From J. Nuytinck 2000-010, 2001-022 and 2001-073. Scale bars = 10 μ m, small bars indicate the height of the hymenium.

Picea-plantation, 30.09.1995, R. Walleyn 0379 (GENT) – Nukerke, Visputten, IFBL: E2.48.42, under *Picea*, 28.09.1998, leg. W. Termonia, R. Walleyn 1892 (GENT) – Ruisseau d'Alise, direction Moulin de Chestion, Forêt domaniale, under *Picea* on acidic soil, 25.09.2000, J. Nuytinck 2000-002 (GENT) – Kessel-lo, entrance Wimmershof IFBL: E5.14.42, in lawn, underneath *Picea*, on lawn, 21.10.2000, J. Nuytinck 2000-010 (GENT) – Road between Bourdon and Marenne, N50°14.661' E005°24.422', 268 m a.s.l., in mixed forest under *Picea abies*, calcareous soil, at road side in grass, 22.09.2001, J. Nuytinck 2001-041 (GENT) – Barvaux, les Mignéés, IFBL: H7.21.22, with young *Picea* trees on dry, calcareous soil, 30.09.2001, R. Walleyn 2183 (GENT)

– Close to Roly, S of Philippeville, under *Picea abies*, 4.09.2002, J. Nuytinck 2002-013 (GENT) – Waulsort (Close to Dinant), in mixed forest under *Picea abies* on calcareous soil, 25.09.2002, J. Nuytinck 2002-018 (GENT) – **Czech Republic**, South Bohemia, Malonty, Hodonický potok, 7353a (SZ grid), ~630 m a.s.l., under young *Picea* on sandy, acid soil, 25.09.2003, R. Walley & A. Verbeken 3198 (GENT) – **Denmark**, W-Jylland, Varming plantage, W of Ribe, UTM: MG9427, *Picea*-plantation, 28.09.1996, leg. M. Christensen, AV 96-1004 (GENT) – NEJ: Rubjerg Knude Plantage, UTM: NJ4667, under *Picea* in *Abies* dominated forest on sandy, calcareous soil, 17.10.1996, J. Vesterholt 96-332 (GENT) – *ibid.*, in *Abies* dominated forest on sandy, calcareous soil, no *Picea* seen nearby, but *Picea* occurs scattered in the plantation., 17.10.1996, J. Vesterholt 96-333 (GENT) – **France**, Beaulieu-en-Argonne, young *Picea* plantation, 31.10.1988, R. Walley & A. Verbeken 88/39bis (GENT) – Saint Germain de Jaux (Ain), 1100m, mixed *Picea-Abies* wood, calcareous soil, 5.09.1999, leg. A. Bidaud, P.A. Moreau 5-9-99 (pers. herbarium P.A. Moreau), as *L. fennoscandicus* – **Germany**, Eifel, Wallersheim Wald, under *Picea*, 18.10.1984, I. Cauwels 84-10 (GENT) – Eifel, Dupbach, *Picea* forest, 10.09.1986, B. Buyck 2434 (GENT) – Eifel, Kopp, *Picea* forest, 11.09.1986, B. Buyck 2440 (GENT) – Eifel, Kopp, *Picea abies*, 24.09.1993, A. Verbeken 93-65 (GENT) – Baden-Württemberg, Welzheim, Wieslaufschlucht, 14.10.1997, V. Walther 4006348 (GENT) Duplum ex 4006348 KR – Baden-Württemberg, Tiefenbronn, MTB 7118/4.21, *Picea* reforestation, slightly acidic soil (?), under *Picea abies*, *Betula*, *Abies* and *Pinus*, 28.10.2001, A. Gminder (GENT) – **Italy**, 13 km from Castel del Monte, N42°23.062' E013°45.365', 1433 m a.s.l., small mixed conifer forest on slope, under *Picea abies*, 1.11.2001, J. Nuytinck 2001-099 (GENT) – *ibid.*, 1.11.2001, J. Nuytinck 2001-100 (GENT) – Trentino, N46°01.555' E011°13.035', 773 m a.s.l., in mixed forest, under *Picea abies*, calcareous soil, 2.10.2002, J. Nuytinck 2002-021 (GENT) – Maso Postel, Trentino, in mixed forest, under *Picea abies*, calcareous soil, 3.10.2002, leg. R. Flores, JN 2002-022 (GENT) – Maso Postel (Pergine Valsugama), Trentino, N46°02.254' E011°12.761', 824 m a.s.l., under *Picea abies*, calcareous soil, 4.10.2002, J. Nuytinck 2002-024 (GENT) – **Netherlands**, Adamskamp (close to Winterswijk), under *Picea*, 8.10.2000, J. Nuytinck 2000-005 (GENT) – Stokhem, Limburg, under *Picea* and *Pinus* on calcareous soil, 29.09.2001, leg. P-J Keizer, J. Nuytinck 2001-128 (GENT) – **Norway**, Akershus county, Nannestad municipality, Tromte, biological station, N60.16 E11.2, 200 m a.s.l., 15.09.1996, A. Verbeken 96-917 (GENT) – **Slovakia**, Velka Fatra hills, Dubina forest in Gaderska dolina valley, 5 km NE of Blatnica village, N48°57.030' E018°57.271', 542 m a.s.l., *Picea abies* forest on steep slope, with *Quercus* trees on top of hill, 5.10.2001, J. Nuytinck 2001-053 (GENT) – *ibid.*, 5.10.2001, J. Nuytinck 2001-054 (GENT) – *ibid.*, 5.10.2001, J. Nuytinck 2001-055 (GENT) – Turcianska kotlina valley, Diviacky haj forest, 3 km W from Turcianska Teplice town, N48°51.861' E018°50.223', 494 m a.s.l., Mixed forest with mainly *Picea abies*, 5.10.2001, J. Nuytinck 2001-056 (GENT) – *ibid.*, 5.10.2001, J. Nuytinck 2001-057 (GENT) – Nizke Tatry mountains, 2.5 km N to Maluzina village, Michalovo valley, N49°00.156' E019°45.481', 674 m a.s.l., swampy place along river with *Picea abies* and some deciduous trees, 6.10.2001, J. Nuytinck 2001-072 (GENT) – *ibid.*, 6.10.2001, J. Nuytinck 2001-073(1) (GENT) – Nizke Tatry mountains, 2 km S of Dubove village, 750 m a.s.l., open forest with *Pinus sylvestris* and *Picea abies*, 8.10.2001, J. Nuytinck 2001-075 (GENT) – Nizke Tatry mountains, 2.5 km S of Dubove village, N49°00.485' E019°31.038', 761 m a.s.l., open *Picea abies* forest, 8.10.2001, J. Nuytinck 2001-076 (GENT) – *ibid.*, N49°00.423' E019°30.999', 765 m a.s.l., open *Picea abies* forest, 8.10.2001, J. Nuytinck 2001-077 (GENT) – *ibid.*, N49°00.400' E019°30.986', 767 m a.s.l., open *Picea abies* forest, 8.10.2001, J. Nuytinck 2001-078 (GENT) – *ibid.*, N49°00.393' E019°30.977', 769 m a.s.l., open *Picea abies* forest, 8.10.2001, J.

Nuytinck 2001-079 (GENT) – Nizke Tatry mountains, Demanovska dolina valley, 7 km S of Demanova village, N49°00.019' E019°34.995', 772 m a.s.l., *Picea abies* forest along river on calcareous soil, 9.10.2001, J. Nuytinck 2001-080 (GENT) – *ibid.*, 9.10.2001, J. Nuytinck 2001-081 (GENT) – **Sweden**, Jämtland, 5 km SE of Brunflo, in rich mixed forest, 4.09.1997, J. Vesterholt 97-217 (GENT) – Jämtland, Bräcke, Gimán, under *Picea* on dry and rich soil, 5.09.1997, J. Heilmann-Clausen 97-176 (GENT) – West of Ange in *Picea*-forest, 7.09.1997, A. Verbeken 97-561 (GENT) – Borgsjö, youth hostel, N62°32.466' E015°54.060', ~240 m a.s.l., grassy place, under *Picea abies* on calcareous ground, 25.08.2001, J. Nuytinck 2001-008 (GENT) – Borgsjö, nearby E14, direction Ange, upside hill, N62°33.252' E015°52.312', ~180 m a.s.l., rich calcareous soil, under *Picea abies*, between grass and fallen needles, 26.08.2001, J. Nuytinck 2001-010 (GENT) – Borgsjö, nearby E14, direction Ange, nearby lake, N62°33.128' E015°52.277', ~150 m a.s.l., Close to swamp, under *Picea abies*, rich soil, 26.08.2001, J. Nuytinck 2001-011 (GENT) – Graveyard of Brunflo, N63°05.469' E014°49.141', ~430 m a.s.l., in lawn under *Pinus strobus*, 27.08.2001, J. Nuytinck 2001-014 (GENT) – Nearby Östersund, N63°10.265' E014°31.784', ~500 m a.s.l., under *Picea abies* on rich soil, 27.08.2001, J. Nuytinck 2001-015 (GENT) – Ange, opposite Shell station, N62°31.481' E015°40.085', ~150 m a.s.l., in grass under *Pinus cembra*, 28.08.2001, J. Nuytinck 2001-017 (GENT) – Nearby Borgsjö, ~5 km along small side road of E14, N62°32.230' E016°06.121', ~150 m a.s.l., Along river, in *Picea abies* and *Betula* forest, 28.08.2001, J. Nuytinck 2001-019 (GENT) – Ange, opposite Shell station, N62°31.481' E015°40.085', ~150 m a.s.l., in grass under *Pinus cembra*, 29.08.2001, J. Nuytinck 2001-022 (GENT) – Bergasen, mountain close to Borgsjö, ~N62°32.673' E015°54.748', ~230 m a.s.l., mixed forest with *Pinus*, *Picea*, *Betula* and *Salix*, rich, calcareous soil, 30.08.2001, J. Nuytinck 2001-026 (GENT) – *ibid.*, ~180 m a.s.l., mixed forest with *Pinus*, *Picea*, *Betula* and *Salix*, rich, calcareous soil, nearby river, 30.08.2001, J. Nuytinck 2001-029 (GENT) – **Switzerland**, Adelboden, 1km NW of the village, 1800 m a.s.l., under 80 yr old *Picea abies*, on slope exposed to E, soil with slate and limestone, with loamy upper layer, 28.07.2001, leg. P.J. Keizer, J. Nuytinck 2001-038 (GENT).

DISCUSSION: *L. deterrimus* is associated with *Picea*, it has a characteristic bright orange stipe without scrobicules, with a white zone at the top. The pileus is orange with green and not to slightly zonate; the bright orange latex generally turns red in 15–20 min. The epitheton 'deterrimus' means 'the worst' and this name was chosen by Gröger (1968) because of the bitter taste. In some regions however this species (or actually a mix of any *Lactarius* sect. *Deliciosi* species) is very popular for consumption.

Although this common taxon was only given a species rank in 1968, it was recognised as a distinct variety from *L. deliciosus* before (Vassilkov 1948 as *L. deliciosus* var. *piceae*, Smotlacha 1947 and Romagnesi 1958 as *L. deliciosus* var. *piceus*, see also under *L. deliciosus*). *L. deterrimus* is more common than *L. deliciosus* in large parts of central and eastern Europe (Gröger 1968, Schaefer 1970). This explains why *L. deterrimus* is most frequently depicted as *L. deliciosus* by eastern European authors from the first half of the 20th century (e.g. Britzelmayr 1885, Michael 1895–1905 & 1927, Gramberg 1921, Lange 1940, Smotlacha 1947, Pilát 1951, Pilát & Ušák 1951).

Neuhoff (1956) created confusion concerning the identities of *L. deterrimus* and *L. semisanguifluus* by describing *L. deterrimus* as *L. semisanguifluus*.

Hesler & Smith (1979) consider the species as one of their numerous varieties of *L. deliciosus*. We are not convinced that this American taxon is conspecific with

the European one, as molecular analyses show that so far not one American species of *Lactarius* sect. *Deliciosi* is conspecific with the European taxa (Nuytinck et al. in preparation).

Three *L. deterrimus* collections (J. Nuytinck 2001-014, J. Nuytinck 2001-017 and J. Nuytinck 2001-022) from Sweden, were growing underneath introduced *Pinus* trees (*Pinus strobus* L. from eastern North America and *Pinus cembra* L. from the Alps and Carpathians). A switch of host tree may have occurred, but it is also possible that *Picea* trees were nevertheless present in the close environment.

4. *Lactarius fennoscandicus* Verbeken & Vesterh., Cryptog. Mycol. 19: 87 (1998)

Fig. 4

Misapplication: = *L. deterrimus* p.p. ss. M. Korhonen, Suomen rouskut (1984), photos p. 108 and 109 (Sipoo 2758 and Vantaa 4882)

Holotype: Verbeken 97-530 (GENT!), Sweden: Siljanfors.

DESCRIPTION: *Pileus* 3–8 cm diam., convex with a slightly depressed centre and a decurved margin, later becoming more depressed; surface smooth and sticky to slightly viscid, distinctly zonate with very narrow zones at the extreme margin and fewer, broader zones near the inside, with a generally dark appearance, background (pale) brownish orange (5/6C3/4) to greyish pink (7D3 to 8D2) with darker, brownish zones (7D6, 7E5 to 8D4), centrally reddish brown (6D7) with darker brown spots (6E4), locally green to bluish green. *Lamellae* slightly decurrent, medium crowded and rather narrow and thin, sometimes branching; colour (pale) orange (5B5/6 to 6B6), slowly turning green where bruised; edge entire and concolorous. *Stipe* 4–8 (11) × 1–2.5 cm, cylindrical or slightly broader near the base; surface dry, slightly pruinose, dull-coloured, pinkish buff to brownish orange (6B4, 6D7), often with a narrow white zone at the extreme apex, without scrobicules, turning green where bruised. *Context* rather to moderately firm, becoming hollow in the stipe, whitish in the central part, bluish grey (21B2) directly underneath the pileipellis, becoming green-grey (28B3) after 1–2 h, bright orange (6A8) above the lamellae and near the stipitipellis, orange parts becoming red in about 30 min. and green after several hours; smell indistinct or very slightly fruity; taste mild or becoming a little acrid and bitter. *Latex* rather scarce, orange (7C8), drying red and then green to greenish grey on the context. *Spore deposit* pale yellow-orange (4A3).

FeSO₄ no reaction, *KOH* no reaction, *phenol* no reaction.

Spores 6.8–7.5–9.4–10.2 × 5.6–6.1–6.9–7.9 µm, broadly ellipsoid to ellipsoid, rarely subglobose (*Q* = 1.10–1.22–1.41–1.50); ornamentation up to 0.5 µm high, of narrow ridges and often abundant rather thick isolated warts, forming an incomplete reticulum; plage very slightly amyloid distally or inamyloid. *Basidia* 40–60 × 9–11 µm, ± cylindrical to subclavate, 4-spored, with a granular content; sterigmata 4–5 µm long. *Pleuromacrocystidia* rather scarce but more abundant near the lamella edge, 35–55 × 4–8 µm, emergent, subfusiform, with a narrowing or moniliform apex, with a needle-like or granular content, thin-walled. *Pseudocystidia* very abundant, 3–5 µm broad, not to slightly emergent, rarely clearly emergent, cylindrical but rather tortuous near the subhymenium, with an indistinct ochre-yellow content, almost invisible near the apex. *Lamella edge* sterile with mostly very few to rarely abundant cheilomacrocystidia; cheileptocystidia 8–20 × 3.5–9.5 µm, subclavate or ± cylindrical to irregular, hyaline, thin-walled; cheilomacrocystidia 15–35 × 4–7.5 µm, subfusiform to fusiform, with a

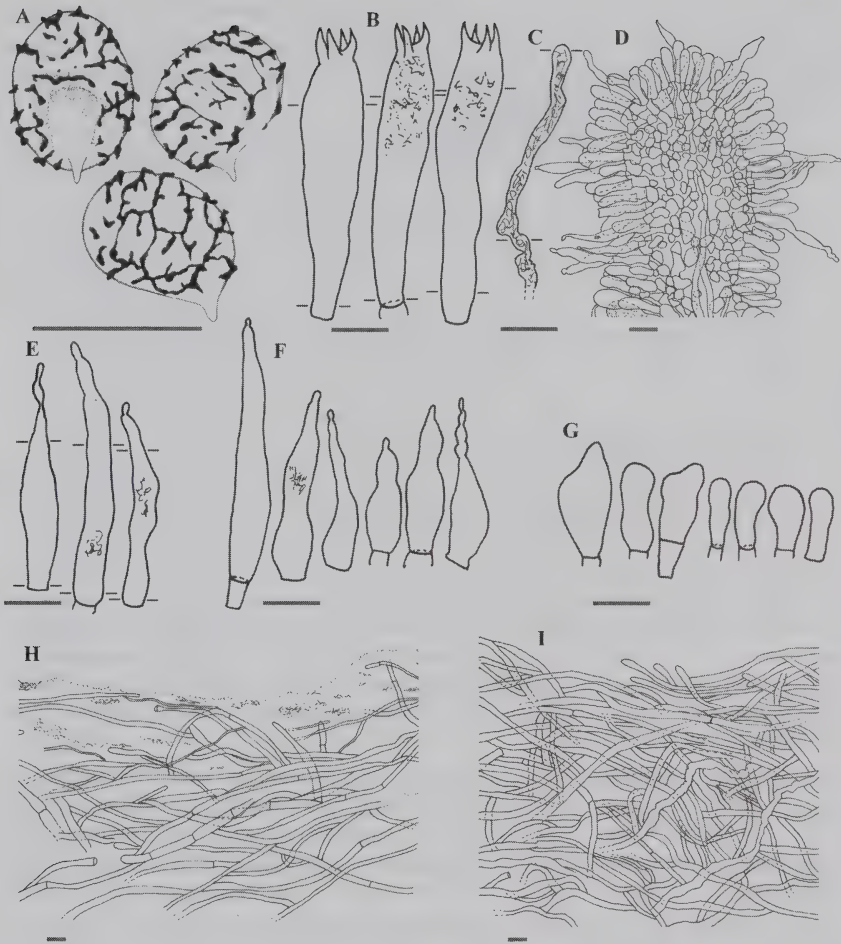


Fig. 4: *Lactarius fennoscandicus*: A. spores; B. basidia; C. pseudocystidium; D. lamella edge; E. pleuromacrocystidia close to the lamella edge; F. cheilomacrocystidia; G. cheileptocystidia; H. section through the pileipellis; I. section through the stipitipellis. From J. Nuytinck 2001-018, 2001-030, 2001-039 and R. Walley 1577BIS. Scale bars = 10 μm , small bars indicate the height of the hymenium.

narrowing to moniliform apex, thin-walled. *Subhymenium* composed of rather small, globose cells arranged in short rows to irregular. *Hymenophoral trama* irregular; lactifers abundant and conspicuous with an ochre-yellow content. *Pileipellis* an ixocutis, 60–300 μm thick; hyphae 1–5 μm broad, strongly shrivelled and gelatinised in the upper layer, more regularly shaped away from the surface. *Stipitipellis* a cutis, 70–150 μm thick; hyphae 3–5 μm broad, not shrivelled or gelatinised, only rarely branching; lactifers abundant and close to the surface. *Clamp-connections* absent.

HABITAT: Associated with *Picea* and found in late summer and early fall.

DISTRIBUTION: Described from boreal Sweden and Finland where it seems, at least locally, to be almost as common as *L. deterrimus*. More recently reported from higher altitudes in the Alps (Floriani 1999).

COLLECTIONS EXAMINED: **Finland**, Enonkoski, ± 5 km S of town, under *Picea abies*, 1.09.2001, leg. A. Gminder, J. Nuytinck 2001-039 (GENT) – **Sweden**, Jämtland: Fors par., Reva, at Indalsälven, under *Picea*, 23.08.1995, leg. J.H. Petersen, J. Vesterholt etc., J. Vesterholt 95-330 (GENT) – Angermanland, skulenskogens Nationalpark, *Picea*, 28.08.1997, H. Huijsen (GENT) – Liljansfors, in *Picea* forest, acidic soil, with *Sphagnum*, *Vaccinium* etc., 31.08.1997, leg. Christensen M., A. Verbeke 97-530 TYPUS (GENT) – Liljansfors, under *Picea* in mixed rich forest, 31.08.1997, leg. Christensen M., J. Heilmann-Clausen 97-119 (GENT) – Jämtland, Bräcke, Gimn, in moist forest with mosses under *Pinus* and *Picea*, 5.09.1997, J. Heilmann-Clausen 97-183 (GENT) – W of Ange, 7.09.1997, A. Verbeke 97-569 (GENT) – Medelpad, Ange, along Geteraen river, *Picea*-dominated coniferous forest with *Betula* and *Populus tremula* on rich soil, 21.08.1999, leg. G. Redeuilh, R. Walley 1577BIS (GENT) – Nearby road between Hunge and Sidsjö, N62.73° E15.15°, ± 300 m a.s.l., under *Picea abies*, 27.08.2001, J. Nuytinck 2001-012 (GENT) – Prov. Medelpad, under *Picea abies*, on rich ground, 28.08.2001, J. Nuytinck 2001-018 (GENT) – Bergasen, mountain close to Borgsjö, N62°32.825' E015°54.733', ± 230 m a.s.l., mixed forest with *Pinus*, *Picea*, *Betula* and *Salix*, rich, calcareous soil, 30.08.2001, J. Nuytinck 2001-027 (GENT) – ibid., $\pm$ N62°32.825' E015°54.733', ± 230 m a.s.l., mixed forest with *Pinus*, *Picea*, *Betula* and *Salix*, rich, calcareous soil, 30.08.2001, J. Nuytinck 2001-028 (GENT) – Garden near road to Ange (E14), *Picea abies* forest behind garden, 31.08.2001, J. Nuytinck 2001-030 (GENT) – Side road of E14 to Granboda, N62°34.122' E015°44.433', ± 208 m a.s.l., along river in *Picea abies*, *Pinus sylvestris* and *Betula* forest, 31.08.2001, J. Nuytinck 2001-031 (GENT).

DISCUSSION: *L. fennoscandicus* was described from Scandinavia as a close relative of *L. deterrimus* (Verbeke & Vesterholt 1998). It also forms ectomycorrhiza with *Picea*. *L. fennoscandicus* has a strongly zonate cap (containing lilac greyish hues mixed with brownish orange, and locally greenish) and bright orange milk, which is slowly reddening.

The spores are described as remarkably small: 7.5–8.0 x 6.0–6.5 μ m in *L. fennoscandicus* versus 9.5 x 7.5 μ m in *L. deterrimus* (Verbeke & Vesterholt 1998). Another indicated microscopical difference between these species is that cheilomacrocystidia almost completely lack in *L. fennoscandicus* while they are moderately abundant in *L. deterrimus* (Verbeke & Vesterholt 1998). These microscopic differences are not completely confirmed here. From our measurements the spore size does not seem to differ significantly (Fig. 5). There is a general tendency for the cheilomacrocystidia to be more abundant in *L. deterrimus* than in *L. fennoscandicus*, but exceptions occur. 10 to 20 % of the examined *L. fennoscandicus* collections have moderately to very abundant cheilomacrocystidia and 10 % of the *L. deterrimus* collections have very scarce cheilomacrocystidia.

The ITS region was sequenced for a large number of *L. deterrimus* and *L. fennoscandicus* accessions for this project (Nuytinck & Verbeke 2005). We see a division into three clades in the inferred phylogenetic trees, two clades with mainly

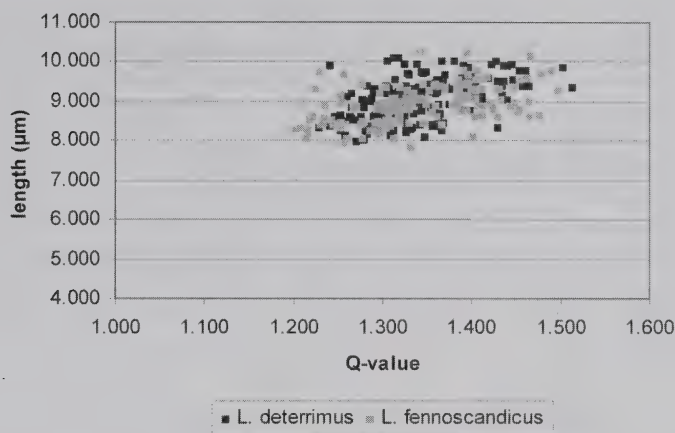


Fig. 5: Length values (in μm) and Q-values plotted against each other for 160 *L. deterrimus* and 160 *L. fennoscandicus* spores. There is a total overlap between both species.

L. deterrimus and one with mainly *L. fennoscandicus* accessions, including the type specimen. The smaller *L. deterrimus* clade clusters with *L. fennoscandicus* in the majority of the MP trees. Moreover, there are several problematic collections: e.g. the *L. fennoscandicus*-like collection from the French Alps falls in the *L. deterrimus* clade, conversely a typical *L. deterrimus* collection from Belgium (J. Nuytinck 2000-002) has one cloned ITS sequence in the large *L. deterrimus* clade while the other is placed in *L. fennoscandicus*. However, based on more detailed and elaborate molecular analyses (AFLP and a total evidence approach including ITS and *gpd* sequences, and morphological characters, for more details see Nuytinck & Verbeken 2005), we conclude that both taxa should be treated as separate species for the moment.

As noted by Verbeken & Vesterholt (1998), an enormous variety can be observed in the appearance of the species of *Lactarius* sect. *Deliciosi* growing with *Picea* in Scandinavia. Apparently, transitional forms between the typical *L. deterrimus* and *L. fennoscandicus* are often encountered. A hypothesis is that *L. deterrimus* and *L. fennoscandicus* are very young, recently evolved species or that the speciation event is actually still going on. A switch of host (from *Pinus* to *Picea* in this case) could have triggered the speciation process, similarly to what happened in *Leccinum* (den Bakker et al. 2004).

5. *Lactarius porninsis* Rolland, Bull. Trimestriel Soc. Mycol. France 5: 168 (1889)

Fig. 6

Note: as *L. porninae* Sacc. in Sylloge Fungorum 9: 57 (1891) and CABI Index of Fungi, named after Mrs. Pornin.

Misapplications: *L. tithymalinus* ss. Quélet (1893); ss. Bataille (1908)

L. aurantiacus ss. Quélet (1880); ss. Bresadola (1929)

Lectotype: Bull. Trimestriel Soc. Mycol. France 5, pl. XIVbis: 2!, depicted from Switzerland, Chamonix (designated in Heilmann-Clausen et al. 1998).

DESCRIPTION: *Pileus* 3.5–12 cm diam., convex with a slightly depressed centre when young, becoming applanate with a depressed centre and a slightly decurved margin, regular but sometimes becoming a bit wavy when older; surface greasy to viscid, then dry, with concentric zones, especially near the margin; colour ochraceous orange, bright orange to brown orange (5A6, 6B6, 6B8, 6C8) often darkest in the centre, paler parts ochraceous salmon to pale cream (5A2–6A6). *Lamellae* slightly decurrent, thin, crowded, sometimes forking near the stipe; colour pale orange-buff (5A5); edge entire, concolorous. *Stipe* 2.5–8 × 0.7–2 cm, ± cylindrical but often slightly broader in the middle, sometimes bent; surface smooth; colour creamy buff, buff-yellow (4A4/5) to (light) ochraceous buff (5A4/5), often with a whitish zone at the top, sometimes with a few, indistinct scobicules. *Context* rather firm, hollow in the stipe; colour whitish, becoming buff with age in the stipe; taste mild at first, becoming bitter; smell fruity, like mandarins. *Latex* not very abundant, white, unchanging; taste mild. *Spore deposit* pale ochraceous buff (4A2).

Spores 6.3–7.7–8.5–9.6 × 5.2–6.0–6.6–7.3 µm, broadly ellipsoid to ellipsoid (Q = 1.15–1.25–1.34–1.45); ornamentation up to 0.5 µm high, of fine ridges, forming an incomplete reticulum with wide meshes, some isolated warts present; plage inamyloid or very slightly amyloid distally. *Basidia* 44–67 × 10.5–12.5 µm, subclavate, 4-spored, often with a fine, granular or needle-shaped content; sterigmata 4–6 µm long. *Pleuromacrocystidia* (very) abundant to dispersed, 41–60 × 6–10 µm, emergent, subfusiform, with a narrowing to moniliform or rarely a forked apex, with a needle-like or granular content, thin-walled. *Pseudocystidia* abundant, 2–5 µm broad, not emergent, cylindrical to tortuous. *Lamella edge* mostly sterile with abundant cheilomacrocystidia; cheileptocystidia 15–30 × 5–12 µm, cylindrical to clavate, hyaline, thin-walled; cheilomacrocystidia 20–40 × 5–8 µm, fusiform, with a narrowing apex, thin-walled. *Subhymenium* composed of almost isodiametric, rather small cells, arranged in short rows. *Hymenophoral trama* irregularly filamentous; lactifers abundant and conspicuous with an opaque to transparent content. *Pileipellis* an ixocutis, 100–200 µm thick, of interwoven, rather broad hyphae, 5–7 µm diam., rarely shrivelled or gelatinised, sometimes branching; extracellular, fine, granular pigment present on some broad hyphae. *Stipitipellis* a cutis, up to 100 µm thick, of interwoven hyphae, 2.5–5.5 µm diam., not gelatinised nor shrivelled. *Clamp-connections* absent.

HABITAT: Ectomycorrhizal with *Larix* (Treu 1990) and found from July to October.

DISTRIBUTION: Common in mountain-forests in central Europe; elsewhere rare and presumably introduced with its mycorrhizal partner, recorded from southern Europe to Denmark (Heilmann-Clausen et al. 1998).

COLLECTIONS EXAMINED: **France**, Hautes-Alpes, Le Casset, ± 1500 m a.s.l., roadside, grassy place under *Larix*, 6.07.1996, A. De Haan 96-008 (GENT) – Savoie, les Arcs 1800, Bourg St.-Maurice, 16.08.1997, R. Walley 1233 (GENT), slides in situ – Savoie, les Arcs 1800, *Larix-Picea*, 17.08.1997, R. Walley 1256 (GENT) – Forêt d'Ecot, Doubs 25, *Larix, Picea* and some deciduous trees, 7.10.1998, leg. M. Pelerin, A. Verbeke 98-081 (GENT) – **Italy**, N46°01.555' E011°13.035', 773 m a.s.l., in mixed forest, under *Larix decidua*, calcareous soil, 2.10.2002, J. Nuytinck 2002-019 (GENT) – Maso Postel, Trentino, in mixed forest, under *Larix decidua*, calcareous soil, 3.10.2002, leg. R. Flores, J. Nuytinck 2002-023 (GENT) – Maso Postel (Pergine Valsugama), Trentino, N46°02.254' E011°12.761', 824 m a.s.l., under *Larix decidua*,

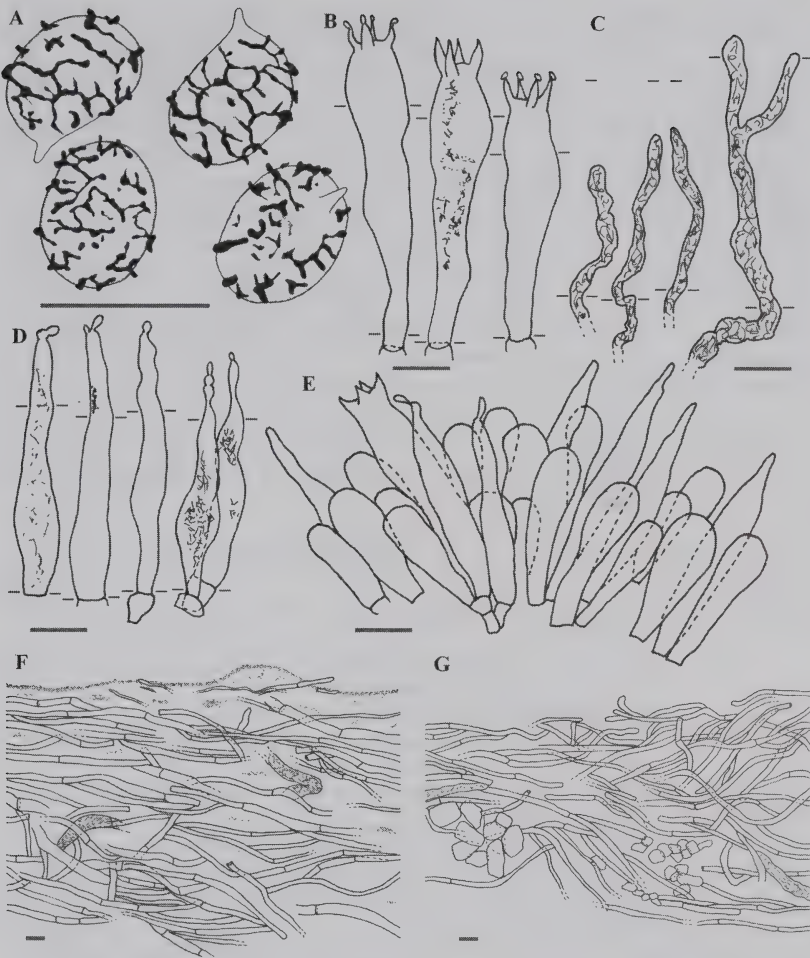


Fig. 6: *Lactarius porninsis*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocyttidia; E. part of the lamella edge; F. section through the pileipellis; G. section through the stipeipellis. From R. Walley 1233 and J. Nuytinck 2001-082, 2002-019, 2002-025. Scale bars = 10 μ m, small bars indicate the height of the hymenium.

calcareous soil, 4.10.2002, J. Nuytinck 2002-025 (GENT) – **Slovakia**, Nizke Tatry mountains, Demanovska dolina valley, 7 km S of Demanova village, Demanovska dolina nature reserve, N49°00.027' E019°35.058', 809 m a.s.l., mixed forest with *Picea abies* and *Larix decidua* on steep slope, 9.10.2001, J. Nuytinck 2001-082 (GENT) – *ibid.*, 9.10.2001, J. Nuytinck 2001-083 (GENT).

DISCUSSION: The combination of an orange and zonate cap, the smell of mandarins, mild-tasting, white latex and a host association with *Larix* makes *L. porninsis* an easily recognizable species.

Heilmann-Clausen et al. (1998) and Basso (1999a) place *L. porninsis* in section *Zonarii* (Quél.) Bon (nom. inval.), subsection *Zonarii* (Quél.) Basso, together with *L. acerrimus* Britzelm., *L. evosmus* Kühner & Romagn., *L. illyricus* Piltaver, *L. zonarius* (Bull.) Fr., *L. zonarioides* Kühner & Romagn. and *L. controversus* Pers.: Fr. All of these species are characterised by a more or less viscid, zonate cap and white, usually unchanging latex. It is surprising to find *L. porninsis* included in the *Deliciosi* clade in the ITS and *gpd*-based phylogenetic trees (Nuytinck & Verbeken 2005). Eberhardt (2000) found the same relationships based on LSU and ITS nrDNA sequences. The position of *L. porninsis* in *Lactarius* section *Deliciosi* can be supported though by some chemical, macroscopical and ecological characters. A study of the secondary latex metabolites in *L. porninsis* showed it is very different from the other *Zonarii* (Marco Cleruzio, pers. comm.). The pileus of *L. porninsis* has an orange and zonate aspect that is remarkably similar to that of species in *Lactarius* sect. *Deliciosi* (Blum 1976) and the species is outstanding in *Lactarius* subsect. *Zonarii* by its association with a coniferous tree (while this is characteristic for all representatives of *Lactarius* sect. *Deliciosi*). Nuytinck et al. (in preparation) show several examples of how a specific latex colour evolved two or more times independently in the section. A loss of pigmentation could explain the position of *L. porninsis*.

6. *Lactarius quieticolor* Romagn., Rev. Mycol. (Paris) 23: 280 (1958)

Fig. 7

- Synonyms: = *L. deliciosus* var. *quieticolor* (Romagn.) J. Blum, Lactaires: 203 (1976), nom. inval.
 = *L. deliciosus* var. *quieticolor* (Romagn.) Krieglst., Beitr. kenntn. Pilze Mitteleuropas 7: 68 (1991), nom. inval.
 = *L. hemicyaneus* Romagn., Rev. Mycol. (Paris) 23: 280 (1958)
 = *L. deliciosus* var. *hemicyaneus* (Romagn.) Krieglst., Beitr. Kenntn. Pilze Mitteleuropas 7: 61 (1991), nom. inval.
 = *L. quieticolor* var. *hemicyaneus* (Romagn.) Basso, Fungi Europaei 7. *Lactarius* Pers.: 275 (1999)
 = *L. deliciosus* var. *indigoides* Kavina, nom. inval., unpublished herbarium name (PR), cited in Schaefer Z., Schweiz. Z. Pilzk. 48 (9): 139 (1970)
 = *L. quieticolor* f. *semisanguinascens* Bon, Rev. Mycol. (Paris) 38: 202 (1975); as 'f. *sanguinascens*' in Bon (1980)
 = *L. pinastri* Romagn., Bull. Trimestriel Soc. Mycol. France 96: 308 (1980)
 Misapplication: *L. sanguineovirescens* ss. Melis et al. (1999)

Holotype: Romagnesi 13-10-1957 (PC!), France: Seine-et-Oise, forêt de Rambouillet.

DESCRIPTION: *Pileus* 4–10.5 cm diam., convex in young specimens, soon a bit depressed, becoming infundibuliform with age, margin at first incurved, then straight, mostly regular; surface smooth, sticky and wet in young specimens but soon becoming dry, strongly zoned when older, especially near the margin, but sometimes only vaguely zoned; colour very variable from one basidiome to another, mostly greyish orange with some brownish tinges (5B/C5), sometimes even deep brown (5F5/6) near the centre, sometimes with dirty orange spots, more rarely brighter orange and similar to *L. deliciosus*, often with irregular green spots; young fruiting bodies (up to 5 cm diam.) sometimes completely deep bluish green (26F4/6). *Lamellae* slightly decurrent to decurrent with a small tooth, moderately to rather distant, medium broad, sometimes

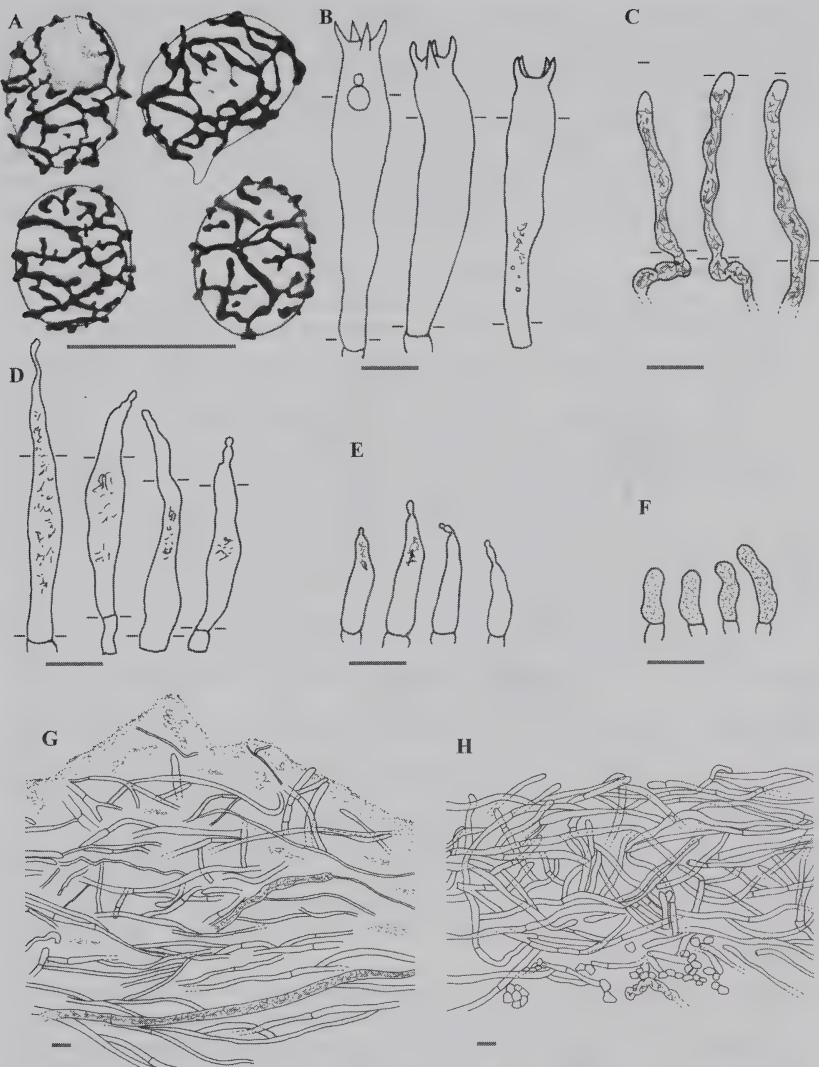


Fig. 7: *Lactarius quieticolor*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis; H. section through the stipeipellis. From J. Nuytinck 2000-009, 2000-011 and 2001-004b. Scale bars = 10 μ m, small bars indicate the height of the hymenium.

forked; colour orange-buff (5A4/5 to 5B5), staining wine red and later green; edge entire, a bit paler. Stipe 4–9 $\times$ 1.2–2.5 cm, cylindrical, often bent, sometimes tapering downwards; surface smooth, rather dry, sometimes scrobiculate and then with regular rounded spots; colour bright to paler orange when young (6/7A6 to 5A5), becoming dirty, pale orange (5B2/3) in older specimens, mostly with a whitish zone right under

the lamellae and often with greenish stains when old. *Context* firm, thick, becoming more brittle and hollow in the stipe, whitish cream-coloured, staining orange (6A7/8) when cut, especially near the pellis, in the stipe especially bright orange near the base, remaining whitish in the most central part, in some specimens with a bright blue zone (24/25DE4) underneath the pileipellis; orange colours turning wine red in 20 min. to maximum 1 h; smell not remarkable, agreeable; taste at first mild and agreeable, then becoming bitter and/or slightly acid. *Latex* not abundant, bright orange (6A7/8), turning wine red and drying greenish on the context; taste mild. *Spore deposit* pale yellow-orange (4A3).

KOH no reaction, *FeSO₄* no reaction, *gaiac* turning blue after 1 min. on context.

Spores 7.9–8.6–9.8–10.4 × 6.1–6.7–7.5–8.3 µm, broadly ellipsoid to ellipsoid ($Q = 1.15\text{--}1.26\text{--}1.36\text{--}1.44$); ornamentation up to 0.8 µm high, of remarkably thick and broad ridges, forming a coarse, almost complete reticulum, some isolated warts present; plate amyloid distally. *Basidia* 48–60 × 8–11 µm, ± cylindrical to subclavate, 4-spored, often containing oil-droplets; sterigmata 2.5–5.5 µm long. *Pleuromacrocystidia* very scarce to rather abundant, 34–60 × 4.5–8 µm, (slightly) emergent, subfusiform, with an acute to (long) moniliform apex, often with a needle-shaped content, thin-walled. *Pseudocystidia* abundant but often hardly visible, 2.5 to 6 µm broad, mostly not emergent, cylindrical to tortuous (especially the lower part). *Lamella edge* sterile with scarce cheilomacrocystidia; cheiloleptocystidia 13–25 × 3–8 µm, cylindrical, subclavate to clavate, hyaline or with a fine, granular content, thin-walled; cheilomacrocystidia 16–33 × 3.5–7 µm, subfusiform to fusiform, with a narrowing to moniliform apex, with a needle-shaped content, thin-walled. *Subhymenium* composed of globose or slightly elongated, small cells. *Hymenophoral trama* very irregular; with abundant lactifers. *Pileipellis* an ixocutis, 50–200 (300) µm thick, with a rather thin slime-layer, composed of thin-walled, branching hyphae, 1–5 µm diam.; gelatinised and very narrow hyphae abundant, most of them with slightly refringent walls. *Stipitipellis* a cutis, ± 100 µm thick, composed of thin-walled, branching, interwoven, regularly shaped hyphae, 3–6 µm diam., no gelatinised or shrivelled hyphae. *Clamp-connections* absent.

HABITAT: Associated with *Pinus*, found from August to October on acid, often sandy, sometimes wet soils.

DISTRIBUTION: Locally fairly common, distributed throughout the area where its mycorrhizal host is present.

COLLECTIONS EXAMINED: **Austria**, Nordtirol, Vomperberg, 900 m a.s.l., 23.10.1993, Plenck 166/93 (GENT), Duplum ex KR 166/93, as *Lactarius deliciosus* var. *hemicyaneus* – **Belgium**, Wingene, Gulke putten, IFBL: D2.13.24, in lawn, under *Pinus sylvestris*, on acidic soil, 13.10.1987, B. Buyck 2677 (GENT) – Herselt, Langendonken, IFBL: D5.26.43, *Pinus sylvestris* on nutrient-poor soil, 21.10.1995, R. Walley 0425 (GENT) – *ibid.*, 21.10.1995, R. Walley 0426 (GENT) – *ibid.*, *Pinus*, acidic soil, humid, 13.10.1996, R. Walley 595 (GENT) – Wingene, Gulke putten, IFBL: D2.13.24, grassland, under *Pinus*, 4.10.1998, R. Walley 1503 (GENT) – *ibid.*, 4.10.1998, R. Walley 1504 (GENT) – *ibid.*, 20.10.2000, J. Nuytinck 2000-009 (GENT) – Ussel, Drongengoed, under *Pinus*, 30.10.2000, J. Nuytinck 2000-011 (GENT) – *ibid.*, in mixed *Pinus* and *Picea* forest, on acidic soil, 28.09.2001, leg. O. Van de Kerckhove, J. Nuytinck 2001-042 (GENT) – Wingene, Gulke Putten, Under *Pinus sylvestris*, on acidic soil, 9.10.2002, leg. A. Verbeken, J. Nuytinck 2002-032 (GENT) – Wachtebeke-

Moerbeke, Heidebos, under *Pinus*, in grassy place, 11.11.2002, J. Nuytinck 2002-048 (GENT) – Patersmote Marke, IFBL: E2.32.13, *Pinus*, 10.11.2003, leg. C. Hanssens, R. Walley 3324 (GENT) – **Czech Republic**, South Bohemia, Malonty, Hodonický potok, 7353a (CZ grid), ~ 630 m a.s.l., under young *Pinus* on sandy acidic soil, 25.09.2003, R. Walley & A. Verbeken 3193 (GENT) – **Denmark**, WJ: Marbaek Plantage N of Esbjerg, UTM: MG5758, under *Pinus*, 2.10.1994, J. Vesterholt 94-766 (GENT) – Marbaek, West Coast, 1.10.1996, A. Verbeken 96-1024c (GENT) – **France**, Lande de Lessay, forêt de PIROU (Manche), in *Pinus pinaster* forest on acidic soil, 30.08.1971, H. Romagnesi 71-214 (PC), *Lactarius pinastri* TYPE – Forêt Domaniale de Fontainebeau, south of Gave de Thomery, under *Pinus sylvestris*, mixed with some *Carpinus* and *Betula*, on sandy, acid soil, almost no herbs, 5.10.2001, leg. P.J. Keizer, J. Nuytinck 2001-130 (GENT) – **Germany**, Rheinland-Pfalz, Ludwigswinkel, NSG Rösselsweiher, 23.09.1979, A. Bollmann 563/91 (GENT), Duplum ex KR 563/91, det. H. Schwöbel as *Lactarius deliciosus* var. *hemicyaneus* – **Italy**, Mt. Cresia, commune di Sinnae-CA, 620 m a.s.l., *Pinus radiata*, 18.10.1997, Contu M., Mua A. & Melis M., LSV 181097, as *Lactarius sanguineovirens* – **Netherlands**, Drenthe, 3.10.2001, leg. S. Van der Linde, J. Nuytinck 2001-127 (GENT) – **Slovakia**, Bratislava, under *Pinus sylvestris*, 8.10.2001, J. Nuytinck 2001-084 (GENT) – **Sweden**, road to Mora, Rather grassy place under *Pinus sylvestris*, poor, acidic soil, 24.08.2001, J. Nuytinck 2001-004a (GENT) – *ibid.*, 24.08.2001, J. Nuytinck 2001-004b (GENT).

DISCUSSION: *L. quieticolor* has a highly variable pileus colour: from greyish and brownish orange to brick, often with green tones. The latex typically changes from orange to wine red in about 20 min. This species prefers acid, often sandy soils and grows with *Pinus*. Microscopically, the species is (easily) recognisable because of the coarsely ornamented spores. The abundance of macrocystidia is less reliable because highly variable.

Confusion with *L. deliciosus* may arise when pale orange forms of *L. quieticolor* are found. In these cases, examining the spore ornamentation is needed for exact identification.

Bon (1975) described *L. quieticolor* f. *semisanguinascens*, a form with orange latex changing to vinaceous red in 15 min. Although *L. quieticolor* was originally described having unchanging orange latex (Romagnesi 1958), personal observations show that most *L. quieticolor* basidiocarps have latex changing colour rather quickly (see also Reil 1992), some have slowly changing latex (after about 1 hour), but they always end up with wine-red latex.

L. quieticolor shows a remarkable variability in pileus colour. This can even be observed within one and the same mycelium. For this reason, we are not in favor of subdividing *L. quieticolor* in varieties and forms.

Verbeken & Vesterholt (1998) synonymize *L. hemicyaneus* with *L. quieticolor*. Both taxa have identical microscopical features and the only macroscopical difference, the bright blue zone underneath the pileipellis in *L. hemicyaneus*, is shown to be very variable within one collection of basidiocarps, occurring more often in young specimens. This is also reported by Krieglsteiner (1991) who observed *L. hemicyaneus* basidiocarps of the same mycelium for several successive years and saw the blue zone becoming weaker as the mycelium aged, and finally disappearing. We included specimens with a very clear blue to bluish green zone in our phylogenetic analyses. They do not form a separate clade in our trees (Nuytinck & Verbeken 2005). It is commonly observed

that specimens with a very dark coloured pileipellis have a clear bluish green zone underneath the pileipellis.

The type specimen of *L. pinastri* was carefully checked, no microscopical differences were found with *L. quieticolor*. The spores are ornamented with heavy ridges, forming an almost complete, dense reticulum with warts up to 0.8–1 µm high. Macrocystidia are scarce to very scarce, on the edge as well as the face of the lamellae. It is synonymised with *L. quieticolor* (see also Heilmann-Clausen et al. 1998).

7. *Lactarius salmonicolor* R. Heim & Leclair, Rev. Mycol. (Paris) 18: 221 (1953)

Fig. 8

Replaced synonym: = *L. salmoneus* R. Heim & Leclair, non Peck (1998), Rev. Mycol. (Paris) 15: 79 (1950)

Synonyms: = *L. subsalmoneus* Pouzar, Česká Mykol. 8: 44 (1954)
 = *L. deliciosus* var. *salmoneus* (R. Heim & Leclair) Kühner & Romagn., Flore Analytique des Champignons Supérieurs: 474 (1953)
 = *L. salmonicolor* f. *brigantiacus* L. Remy, Bull. Trimestriel Soc. Mycol. France 80: 487 (1965), nom. inval., nom. nud.
 = *L. deliciosus* var. *abietinus* Smotl., Atlas hub jedlých a nejdělků [Atlas of edible and inedible fungi]: 219 (1947), nom. inval., nom. nud.
 ? = *L. flammeolus* (Pollini: Fr.) Fr., Epicr. Syst. Mycol.: 341 (1838)
 = *Agaricus flammeolus* Pollini, Giorn. Fis. 9: 34 (1816)

Lectotype: no information available on the number of the type collection (PC), described from France: Bellême.

DESCRIPTION: *Pileus* 4.5–19 cm diam., when young convex with a slightly depressed centre, becoming infundibuliform when full-grown with a straight to inrolled margin, sometimes with an irregularly shaped to lobed margin; surface smooth and viscid; colour salmon orange (6A5), sometimes paler (light) ochraceous buff (5A4/5), typically clearly and finely zonate near the margin with the darker zones ochraceous orange-coloured (5A6/7 to 6A6/7), greenish tones almost always completely absent, only very small and very old specimens with some green discolouration. *Lamellae* slightly decurrent, with an (indistinct) decurrent tooth in older specimens, moderately spaced, often anastomosing near the insertion of the stipe; colour salmon orange or slightly paler (5A6/5), turning red when bruised and sometimes very faintly green after some hours; edge entire and concolorous. *Stipe* 2–7 × 0.8–2.5 cm, ± cylindrical, rather long and slender to rarely more short and robust, becoming hollow; surface dry to viscid, smooth; colour salmon orange or slightly more bright orange (6A5/6), sometimes with an unclear white bloom (5A3), deeper orange (6A7) scrobiculates very conspicuous in most specimens and often large; stipe sometimes with a white zone at the top, without green tinges. *Context* firm, whitish, underneath the stipitipellis and in the entire pileus bright orange when cut (6A8 to 7A8), then (slowly) turning red: scarlet (8A/B8) after 20 min., vinaceous red (9D7) after 30 min., vinaceous brown after 1h; smell slightly fruity; taste mild to slightly acrid and then bitter after 10 sec. *Latex* scarce to rather abundant, bright orange (7A8), drying vinaceous red in 20–30 min. on the context; taste mild. *Spore deposit* pale yellow-orange (4A3).

Spores 8.5–10.0–10.6–11.8 × 6.7–7.3–8.2–9.0 µm, ellipsoid, rarely broadly ellipsoid ($Q = 1.16–1.27–1.35–1.54$); ornamentation up to 0.5 µm high, of rather narrow ridges with abundant short ridges and isolated warts, forming an incomplete reticulum; plage

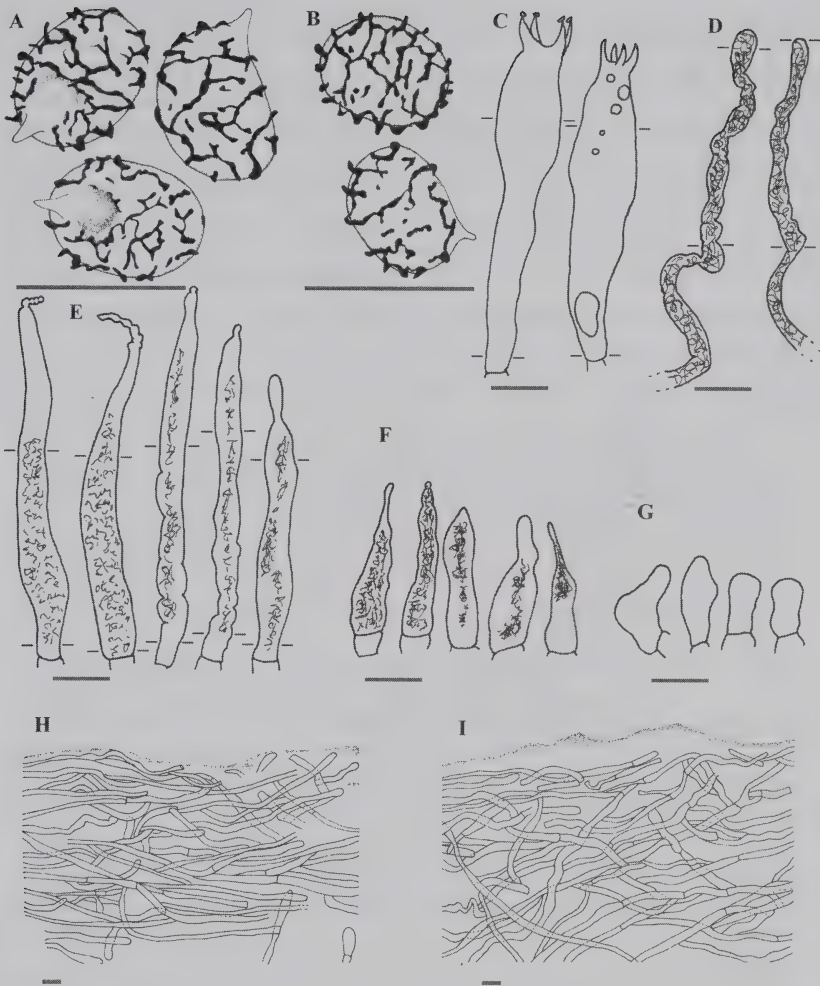


Fig. 8: *Lactarius salmonicolor*: A. spores; B. significantly smaller spores from J. Nuytinck 2002-027; C. basidia; D. pseudocystidia; E. pleuromacrocystidia; F. cheilomacrocystidia; G. cheileleptocystidia; H. section through the pileipellis; I. section through the stipitipellis. From A. Verbeken 98-056, R. Walley 3257 and J. Nuytinck 2001-067, 2001-085, 2001-123, 2002-027, 2002-030. Scale bars = 10 μ m, small indicate the height of the hymenium.

clearly visible and rather big but only slightly amyloid distally. *Basidia* 40–64 $\times$ 10–14 μ m, almost cylindrical to subclavate, 4-spored, often containing oil droplets; sterigmata 3–7 μ m long. *Pleuromacrocystidia* 40–96 $\times$ 6–12 μ m, abundant over the entire lamella face, conspicuous and very emergent, $\pm$ cylindrical to fusiform, often with a moniliform apex, often with a granular to needle-like content, thin-walled. *Pseudocystidia* quite abundant, slender, 2–4 μ m broad, mostly not to slightly (but rarely clearly) emergent,

cylindrical to irregularly tortuous, content similar to the lactifers. *Lamella edge* sterile with abundant cheilomacrocystidia; cheiloleptocystidia $15\text{--}30 \times 5\text{--}8 \mu\text{m}$, $\pm$ cylindrical to irregular, thin-walled; cheilomacrocystidia $24\text{--}45 \times 4\text{--}7 \mu\text{m}$, fusiform, with a moniliform apex, most often with a needle-shaped content, thin-walled. *Subhymenium* irregular, composed of globose or slightly elongated, small cells. *Hymenophoral trama* irregular; with very abundant lactifers. *Pileipellis* an ixocutis, up to $350 \mu\text{m}$ thick, with a thin and indistinct slime-layer, of frequently branching and interwoven hyphae, $2\text{--}6 \mu\text{m}$ diam., only few shrivelled hyphae. *Stipitipellis* an ixocutis, up to $200 \mu\text{m}$ thick, with a distinct ($10\text{--}20 \mu\text{m}$ thick) slime-layer, composed of frequently branching and interwoven hyphae, $2\text{--}5 \mu\text{m}$ diam., few shrivelled hyphae. *Clamp-connections* absent.

HABITAT: Forming ectomycorrhiza with *Abies* (Pillukat 1996a&b, Eberhardt et al. 2000), on calcareous soils, found from September to November.

DISTRIBUTION: Distributed widely in Europe where the host tree occurs, not known from Scandinavia.

COLLECTIONS EXAMINED: **Belgium**, Rochefort, Les Fèches, under *Abies*, young plantation, 5.10.1996, A. Verbeken & R. Walley 96-1033 (GENT) – *ibid.*, 6.10.1996, R. Walley 0570 (GENT) – *ibid.*, $N50^{\circ}10.209' E005^{\circ}10.398'$, 189 m a.s.l., in *Abies alba* plantation, 27.10.2001, J. Nuytinck 2001-085 (GENT) – *ibid.*, 27.10.2001, J. Nuytinck 2001-086 (GENT) – *ibid.*, 27.10.2001, J. Nuytinck 2001-087 (GENT) – *ibid.*, 10.10.2002, J. Nuytinck 2002-031 (GENT) – *ibid.*, 30.10.2002, J. Nuytinck 2002-046 (GENT) – **France**, Villaroger (73), “Le Pré Derrière”, 1300 m a.s.l., in a meadow bordered by *Picea*, 25.08.1994, P.A. Moreau 94082501 (GENT) – Forêt de Dorans, Bois de Chevrey, between Dorans and Durbuy, *Abies* forest on rich, calcareous clayey soil, 4.10.1998, A. Verbeken 98-056 (GENT) – Close to Aix les Bains, *Abies alba* plantation on slope, 11.11.2001, J. Nuytinck 2001-123 (GENT) – *ibid.*, 11.11.2001, J. Nuytinck 2001-126 (GENT) – **Italy**, Sardegna, Prov. Sassari, Monte Limbara, Loc. Madonna Della Neve, close to *Abies cephalonica*, 12.06.2000, leg. M. Contu, J. Nuytinck 2002-027 (ex. Herbar. Mycol. M. Contu) – *ibid.*, 17.06.2000, leg. M. Contu, J. Nuytinck 2002-028 (ex. Herbar. Mycol. M. Contu) – *ibid.*, 22.06.2000, leg. M. Contu, J. Nuytinck 2002-029 (ex. Herbar. Mycol. M. Contu) – Chiarino (Passo delle Capannelle), $\sim N42^{\circ}30.376' E013^{\circ}24.679'$, 985 m a.s.l., planted, mixed forest on mountain slope, 29.10.2001, J. Nuytinck 2001-090 (GENT) – *ibid.*, 29.10.2001, J. Nuytinck 2001-091 (GENT) – Sardegna, Prov. Sassari, Monte Limbara, Loc. Madonna Della Neve, close to *Abies cephalonica*, 24.06.2002, leg. M. Contu, J. Nuytinck 2002-030 (ex. Herbar. Mycol. M. Contu) – **Slovakia**, Nizke Tatry mountains; 2,5 km N to Maluzina village, Michalovo valley, $N48^{\circ}59.898' E019^{\circ}45.448'$, 725 m a.s.l., under *Abies alba* in mixed forest on steep slope, 6.10.2001, J. Nuytinck 2001-067 1 (GENT) – *ibid.*, 6.10.2001, J. Nuytinck 2001-067 2 (GENT) – Nizke Tatry mountains; 2,5 km N to Maluzina village, Michalovo valley, $N48^{\circ}59.898' E019^{\circ}45.448'$, 725 m a.s.l., under *Abies alba* in mixed forest on steep slope, 6.10.2001, J. Nuytinck 2001-067 3+4 (GENT) – *ibid.*, 6.10.2001, J. Nuytinck 2001-067 rest (GENT) – Eastern Carpathians, Poloniny N.P., Stuzica virgin forest, terrestrial under *Abies alba*, 5.10.2003, R. Walley 3257 (GENT).

DISCUSSION: *L. salmonicolor* is a medium sized to very large species with a salmon orange coloured cap, typically completely lacking green tinges, often with a strikingly scrobiculate stem and orange milk turning red in $\pm 20\text{--}30$ min. It is outstanding in the section because of its association with *Abies*. The wrong indication of *Picea* as host

tree in the original description caused some initial confusion on the identification of *L. salmonicolor* (e.g. Bertault 1978).

Microscopically the abundant and emergent pleuromacrocystidia are striking. They were mentioned in the original description (Heim & Leclair 1950) and we observed them in all studied specimens. Nevertheless, caution is necessary when using macrocystidia for identification in *Lactarius* sect. *Deliciosi*. In Heilmann-Clausen et al. (1998) the abundant pleuromacrocystidia are not mentioned. The large spore size is another striking microscopical character. The high Q-value as indicated in the original description (Heim & Leclair 1950), refers only to a small portion of the spores (Neuhoff 1956, Heilmann-Clausen et al. 1998).

L. salmonicolor was first described as *L. salmoneus* (Heim & Leclair 1950) and subsequently renamed (Heim 1953) because the name *L. salmoneus* had already been used by Peck (1898) for a North-American species. Little time later Pouzar (1954) proposed the name *L. subsalmoneus* to replace *L. salmoneus*. The name *L. subsalmoneus*, although superfluous, has since then popped up several times. Schaefer (1970) even interpreted *L. subsalmoneus* and *L. salmonicolor* as two different species.

Agaricus flammeolus, described in 1816 by Pollini and combined in *Lactarius* by Fries (1838) is possibly a synonym of *L. salmonicolor* (fide Neuhoff 1956), but several key characters are lacking in the original description.

M. Contu collected deviating *L. salmonicolor* fruiting bodies under introduced *Abies cephalonica* trees in Sardinia. The spores are remarkably smaller than in the typical *L. salmonicolor* collections (Fig. 7) and the pleuromacrocystidia even more abundant, emergent and striking. Molecular analyses however, do not differentiate these collections from the other *L. salmonicolor* accessions (Nuytinck & Verbeken 2005).

L. laeticolor (S. Imai) Imazeki ex Hongo, described from Japan, is strikingly similar to *L. salmonicolor*. Based on this morphological resemblance, *L. laeticolor* has been proposed as a synonym of *L. salmonicolor* (Heilmann-Clausen et al. 1998, Eberhardt et al. 2000). Our molecular data however, reject this hypothesis; both species are closely related but do form separate clades (Nuytinck et al. in preparation).

Similarly, several Mexican collections remind very strongly of *L. salmonicolor*. A molecular and detailed morphological study is needed here to come to reliable conclusions.

8. *Lactarius sanguifluus* (Paulet) Fr., Epicr. Syst. mycol.: 341 (1838)

Fig. 9

Basionym: = *Hypophyllum sanguifluum* Paulet, Traité des champignons: 2 (9ed): pl. 81, fig. 3-5 (1811)

Synonym: = *L. sanguifluus* f. *roseus* Lalli & Pacioni, Micol. Veg. Medit. 17 (2): 121-132 (2003)

Lectotype: Traité des champignons: 2 (9th ed): plate 81, fig. 3-5! (Paulet 1811), depicted from France (**designated here**). Lalli et al. (2003) invalidly neotypified *L. sanguifluus* (AQ (92/15) (AQUI), Italy, L'Aquila, S. Giuliano). Because the drawing by Paulet (1811) does not reflect the typical *L. sanguifluus* morphology, we designate collection AQ (92/15) (AQUI), as the epitype for *L. sanguifluus* (**designated here**).

DESCRIPTION: *Pileus* 4–9 cm diam., convex with a slightly depressed centre, later becoming more depressed but margin remaining slightly incurved, mostly regular; surface smooth, viscid but soon dry, azonate to faintly zoned; colour orange-buff (5A2–4), pinkish buff (6A3) with sometimes ochraceous orange (6B/C7) in an irregular pattern or with ochraceous orange pits, sometimes with greyish green tinges, green to greyish green where bruised. *Lamellae* slightly decurrent, sometimes with a decurrent tooth, medium broad, rather crowded, often forked near the stipe; colour pale vinaceous (7A/B3/4) or with a pale pinkish buff (5B3) tint; edge entire and somewhat paler. *Stipe* 2–4.5 × 1–2.5 cm, mostly cylindrical; surface smooth, dry; colour deep red just where the gills are attached, with a whitish zone mostly present below the lamellae attachment, major part orange-buff (7B3) to orange-red (9A2), pale because of a white surface layer; scrobicules variable in size and abundance, deeper brownish orange (6D7) or more reddish. *Context* rather firm in the pileus, becoming hollow in the stipe, pale pinkish buff but vinaceous to deep wine red (9/10D6) just above the lamellae and under the stipe and pileus surface, drying brownish; smell faint, fruity; taste mild, shortly afterwards becoming very slightly bitter and slightly acid. *Latex* rather scarce, vinaceous red (9/10D6); taste mild. *Spore deposit* pale yellow-orange (4A3).

KOH no reaction, *phenol* no reaction, *NH₄OH* no reaction.

Spores 7.3–8.1–8.8–9.7 × 5.7–6.4–7.1–7.8 µm, mostly subglobose to broadly ellipsoid, rarely ellipsoid ($Q = 1.10\text{--}1.24\text{--}1.29\text{--}1.36$); ornamentation up to 0.5 (0.7) µm high, of rather broad ridges, forming an incomplete reticulum, isolated warts and short ridges numerous; plage distally very slightly amyloid. *Basidia* 50–60 (70) × 9–11.5 µm, subclavate, 4-spored, containing fine granules or oil-droplets; sterigmata 4–6 µm long. *Pleuromacrocyttidia* rather scarce to abundant, 45–65 × 6–9 µm, emergent, subfusiform to fusiform, tapering or moniliform at the apex, with a granular to needle-like content, thin-walled. *Pseudocystidia* abundant, 3–4 µm thick, not to slightly emergent, almost cylindrical to branching and tortuous, sometimes with a mucronate apex. *Lamella edge* sterile with rather scarce to abundant cheilomacrocyttidia; cheileptocystidia 22–30 × 5–8 µm, subclavate to more irregular, with a fine, granular content, thin-walled; cheilomacrocyttidia 35–45 × 6–8 µm, emergent, fusiform, with a moniliform to sometimes branching apex, with a granular to needle-shaped content, thin-walled. *Subhymenium* irregular, appearing like small, subglobose cell in rows under the hymenium elements. *Hymenophoral trama* irregularly filamentous; with abundant lactifers. *Pileipellis* an ixocutis, up to 200 µm thick, with a very thin slime-layer; hyphae 2–6 µm broad, often branching, strongly interwoven, only few gelatinised or shrivelled, mostly with almost refringent walls; lactiferous hyphae locally present. *Stipitipellis* a cutis, up to 150 µm thick, of regularly shaped, strongly interwoven hyphae, 2–5 µm diam., without shrivelled or gelatinized hyphae; thin lactifers present relatively close to the surface. *Clamp-connections* absent.

HABITAT: Associated with *Pinus*, on calcareous soils, rather thermophilous, found from September to November (December in most southern Europe).

DISTRIBUTION: Widespread in mainly southern Europe.

COLLECTIONS EXAMINED: **Belgium**, Nismes, coniferous forest, 15.10.1984, I. Cauwels 84-43 (GENT) – Nismes, Fondri des Chiens, N50°04'26.63" E04°33'31.53", *Pinus sylvestris* on calcareous soil, 19.11.1995, A. Verbeken and R. Walley (GENT) – Ave-et-Auffe, N50°06'75.7" E005°10'39.0", 171 m a.s.l., *Pinus nigra* plantation on calcareous, S-SE exposed slope, 19.10.2000, J. Nuytinck 2000-006 (GENT) – Tellin,

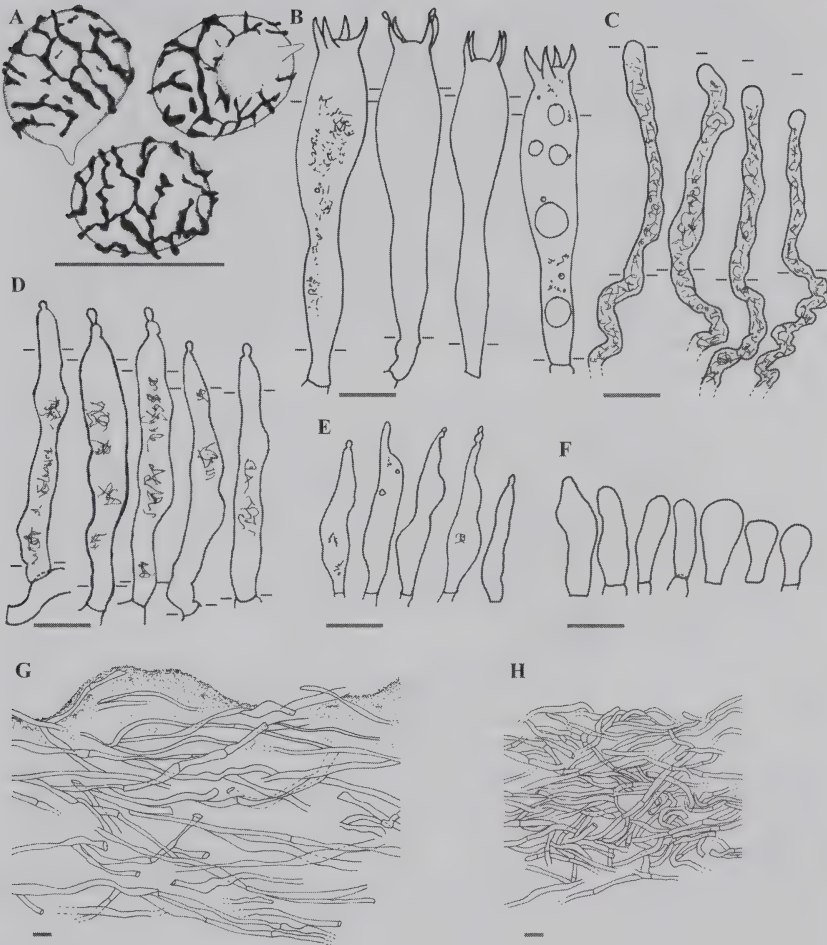


Fig. 9: *Lactarius sanguifluus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheileptocystidia; G. section through the pileipellis; H. section through the stipitipellis. From J. Nuytinck 2000-008, 2001-095 and 2001-097. Scale bars = 10 µm, small bars indicate the height of the hymenium.

in garden under *Pinus*, 19.10.2000, J. Nuytinck 2000-008 (GENT) – Barvaux, les Mignéés, N50°19'46.35" E005°29'12.29", in ruderal grassland on limestone under *Pinus*, 6.10.2001, R. Walley 2193 (GENT) – **France**, Forêt de la Brosse, between Danjoutin and Andelnans, along road near forest with *Pinus*, 5.10.1998, A. Verbeken 98-063 (GENT) – Ramtuelle, Gassin, 16.11.1999, D. Laber 4007287 (STU) – Causse de flames, Coulaures, under *Pinus sylvestris* on calcareous soil, 24.10.1999, A. Verbeken 99-245 (GENT) – Manoïr de Syrignac (Salignac), under *Pinus sylvestris* on calcareous soil, 24.10.1999, leg. H. Van Nieuwenhove, A. Verbeken 99-246 (GENT) – **Germany**, Baden-Württemberg, Schaffhausen, MTB 7219/3.23, Wacholderheide on calcareous soil under *Pinus sylvestris* and *Juniperus communis*, 28.10.2001, A. Gminder (STU)

– **Italy**, Toscana, Cipressata di S. Agnese, on slope in forest dominated by *Cupressus sempervirens* with scattered *Quercus ilex* and *Pinus*, 5.11.1996, J. Vesterholt 96-423 (GENT) – Poggio Roio, N42°20'64.9" E013°22'44.4", 865 m a.s.l., mixed forest on small mountain (*Pinus*, *Abies*, *Picea* and deciduous trees), 31.10.2001, J. Nuytinck 2001-095 (GENT) – *ibid.*, 31.10.2001, J. Nuytinck 2001-096 (GENT) – *ibid.*, 31.10.2001, J. Nuytinck 2001-097 (GENT) – *ibid.*, 31.10.2001, J. Nuytinck 2001-098 (GENT) – **Morocco**, Tamrabta, Under *Pinus maritimus*, 10.11.1953, G. Malençon 2567A&B (MPU) – Marabout Sidi-Bou-Hassan RIF, Under *Pinus halepensis*, 30.11.1960, G. Malençon & R. Bertault 4091 (MPU) – **Slovakia**, Mali Karpaty hills near Ploveckli Podhra die, N48°29'00.2" E017°16'05.2", 320-360 m a.s.l., *Pinus nigra* plantation on S exposed slope, 3.10.2001, J. Nuytinck 2001-051 (GENT) – *ibid.*, 3.10.2001, J. Nuytinck 2001-050 (GENT) – **Spain**, Surroundings of St Hilary Sacalm, 5.11.2001, J. Nuytinck 2001-103 (GENT) – **Sweden**, Gotland, Endre par., Ölbäck, in open calcareous grassland under *Pinus*, 13.10.1996, leg. C. Lange, E. Bohus and P. Johansson, C. Lange 96-080 (GENT).

DISCUSSION: *L. sanguifluus* is a medium-sized to rather large species, associated with *Pinus* and exuding vinaceous red latex when cut. Romagnesi (1958) remarks the accidental occurrence of spots of orange coloured milk at the base of the stipe. The pileus and stipe have a generally dull ochraceous orange appearance; the lamella colour is very characteristic pale vinaceous, clearly more reddish than in *L. deliciosus* but much paler than in the entirely vinaceous coloured *L. vinosus*. Microscopically, the rather small and mostly subglobose, quite heavily ornamented spores are characteristic. *L. sanguifluus* and *L. vinosus* are considered to be some of the most delicious edible species in the Mediterranean area.

L. sanguifluus and *L. vinosus* form two separate clades in the molecular phylogenetic analyses (Nuytinck & Verbeken 2003 & 2005). Maximum parsimony analysis of the ITS nrDNA shows that the two clades are not supported by very high bootstrap values, but a total evidence approach reveals much higher support values. We consider it justified to treat *L. sanguifluus* and *L. vinosus* as separate species as several ecological and macro- and microscopical features distinguish them (see under *L. vinosus*). Sister group to these two species is *L. semisanguifluus* with latex that turns from orange to red in just a few minutes.

Lalli et al. (2003) state that, due to the existence of multiple forms and intermediates and due to the lack of clearly differentiating features, it can be very hard to distinguish species in the "*L. sanguifluus*-complex" (see discussion on nomenclature under *L. vinosus*). The appearance of the cap may indeed change quite drastically with age and even more with exposure to direct sunlight and drought. For this reason, Lalli et al. (2003) described two forms: *L. sanguifluus* f. *roseus* with a greyish-whitish discoloured cap and a general pinkish appearance and *L. sanguifluus* f. *vinosus* with a less clearly zonate cap without much green and a more lilac-pink sheen in the lamellae. The nominate form is stated to have ochre-orange lamellae with a salmon sheen (Lalli et al. 2003). We do not agree with this delimitation of forms as they are part of a continuous morphological variation.

9. *Lactarius semisanguifluus* R. Heim & Leclair, Rev. Mycol. (Paris) 15: 79 (1950) Fig. 10

Synonym: = *L. sanguineovirescens* Fillion, Bull. Trimestriel Féd. Mycol. Dauphiné-Savoie 29 (113): 21 (1989)

Excluded: *L. semisanguifluus* ss. Neuhoﬀ (1956) (= *L. deterrimus*)

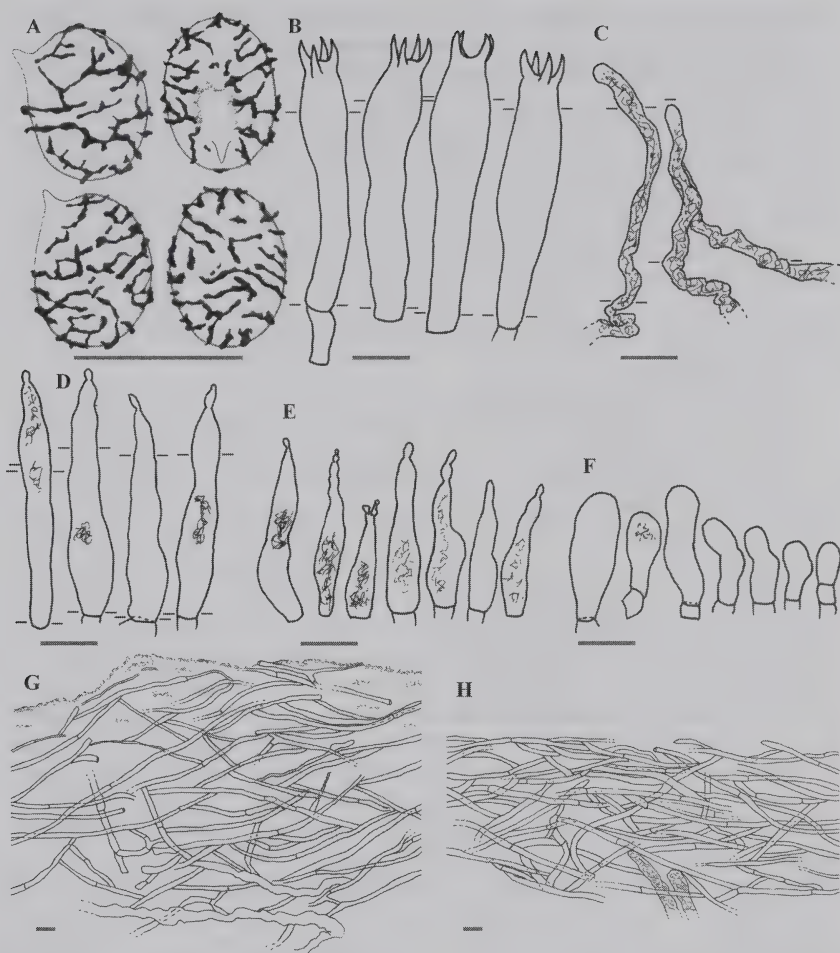


Fig. 10: *Lactarius semisanguifluus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheileptocystidia; G. section through the pileipellis; H. section through the stipitipellis. From A. Peksen & G. Hatat 220, A. Verbeken 96-1032, R. Walley and J. Nuytinck 2001-049, 2001-092. Scale bars = 10 μ m, small bars indicate the height of the hymenium.

Lectotype: Heim 1949-610 (PC!), France: Bellême (**designated here**).

DESCRIPTION: *Pileus* 4–7 cm diam., convex with a slightly depressed centre when young, becoming broadly infunduliform with an inrolled to flattened margin and a slightly depressed centre; surface smooth, sticky but soon becoming dry, (almost) not zonate to slightly zonate (close to the margin) or clearly zonate; colour sometimes bright orange but often dull orange (6B6) or brownish (6C7, 6D7) to greyish orange (6D3), exceptionally greyish with pink and buff shades, discolouring red where bruised, very often with a lot of green. *Lamellae* slightly decurrent, medium broad, medium

crowded, rarely forked or anastomosing; colour pale salmon pink to buff to brighter orange (5A4/7 to 6A6), turning red in 5 min. when bruised, then becoming green (in 30 min. or more); edge entire and slightly paler. *Stipe* 2–6.5 × 0.9–2 cm, ± cylindrical or more irregular; surface smooth, dry; colour pale to brighter orange (5A6 to 6A5), often with a white bloom, turning red and then green where bruised or when old, with (a few) darker orange scrobicules (sometimes absent). *Context* quite firm and thick, also in the pileus margin, becoming hollow in the stipe, whitish but turning bright orange (6/7A8) when cut, changing to red (8C7) in 5–10 min. and becoming deep vinaceous red (8E6 to 10D/E7/8) in 20 min., becoming green in a few hours, zone just underneath pileipellis sometimes greenish from the beginning; smell faintly fruity; taste ± mild or very slightly acrid at first and then becoming bitter. *Latex* scarce, bright orange (6/7A8) but quickly (5–10 min.) drying vinaceous red on the context; taste mild. *Spore deposit* pale yellow-orange (4A3).

KOH no reaction, *NH₄OH* no reaction.

Spores 7.7–8.6–9.0–9.7 × 6.1–6.7–7.0–7.7 µm, broadly ellipsoid to ellipsoid (Q = 1.16–1.28–1.32–1.42), exceptionally large spores rarely present; ornamentation up to 0.5 µm high, of fine ridges and many isolated warts and short ridges, forming a very incomplete reticulum, rarely with slightly thicker ridges; plage slightly amyloid distally. *Basidia* 40–60 × 8.5–11 µm, ± cylindrical to subclavate, mostly 4-spored, rarely 1- or 2-spored; sterigmata 3.5–6.5 µm long. *Pleuromacrocystidia* moderately to quite abundant, 41–64 × 6.5–12 µm, emergent, often with a moniliform apex, with a needle-like or granular content, thin-walled. *Pseudocystidia* abundant, 2.5–5 µm broad, not emergent, cylindrical and tortuous, sometimes branching, with a yellowish content similar to the lactifers. *Lamella edge* sterile with abundant cheilomacrocystidia; cheiloleptocystidia 10–25 × 4–8 µm, cylindrical to subclavate, hyaline or with a fine granular content, thin-walled; cheilomacrocystidia 20–50 × 5–9 µm, subfusiform or irregular with a moniliform apex, with a needle-shaped content, thin-walled. *Subhymenium* irregular, composed of ± isodiametric or elongated cells, arranged in rows under hymenium elements. *Hymenophoral trama* irregular; with abundant lactifers. *Pileipellis* an ixocutis, up to 200 µm thick, composed of interwoven, branching hyphae, 2–7 µm thick; gelatinised and shrivelled hyphae not abundant. *Stipitipellis* a cutis, up to 100 µm thick, composed of interwoven hyphae of 2–6 µm diam. *Clamp-connections* absent.

HABITAT: Associated with *Pinus*, linked to rich, calcareous soils, found from September to November.

DISTRIBUTION: Distributed throughout Europe, but mainly in the southern part, eastwards known up to Turkey.

COLLECTIONS EXAMINED: **Belgium**, Bagrimont, 27.08.1948, M. Herregods 1019 (GENT) Herregods, as *L. sanguifluus* – Heure-en-Famenne, Bois d'Heure, IFBL: D6.36.24, grassy place, *Pinus sylvestris*, 19.09.1994, R. Walley & A. Verbeken 94-737 (GENT) – Nismes, IFBL: J5.41.14, *Pinus sylvestris*, border calcareous grassland, 30.09.1995, R. Walley 0377 (GENT) – Matagne-La Grande, Les Mires, IFBL: J5.23.14, *Pinus sylvestris*, border calcareous grassland, 25.09.1996, R. Walley 0515 (GENT) – Parking place 5 km before Rochefort on road from Ciergnon to Rochefort, *Pinus*, grassy, calcareous soil, 5.10.1996, A. Verbeken 96-1032 (GENT) – Close to Rochefort, S-SE exposed slope, calcareous soil, under *Pinus nigra*, 19.10.2000, J. Nuytinck 2000-007 (GENT) – Resteigne, N50°05.355' E005°10.990', 240 m a.s.l., under *Pinus* on

calcareous soil, on forest path, 22.09.2001, J. Nuytinck 2001-040 (GENT) – Close to Rochefort, N50°10.209' E005°10.398', 189 m a.s.l., under *Pinus sylvestris*, in lawn, 30.10.2002, J. Nuytinck 2002-045 (GENT) – **Denmark**, NEJ: Hostemark Skov S of Mou, UTM: NJ7511, under *Pinus*, 1.10.1994, L. Vesterholt & S. Hansen, J. Vesterholt 94-749 (GENT) – **France**, 1.10.1949, Heim 1949-610 (PC), Lectotype – Close to Bellegarde, Under *Pinus*, on acidic soil, leg. Bon etc., det Bon & Fillion, Bon 88127 (LIP), Isotype of *L. sanguineovirescens* – Sevrier (74), 30.09.2001, P.A. Moreau 30-09-2001 (pers. herbarium P.A. Moreau), as *Lactarius pinastri/sanguineovirescens*? – Minzier, 13.10.2001, P.A. Moreau 13-10-2001 (pers. herbarium P.A. Moreau), as *Lactarius sanguineovirescens* – **Germany**, Baden-Württemberg, Bebenhausen, Goldersbachtal, MTB 7420/1.213, *Picea* and *Pinus*, 4.10.2001, A. Gminder (GENT) – **Italy**, Chiarino (Passo delle Capannelle), N42°30.376' E013°24.679', 981 m a.s.l., small *Pinus nigra* stand on slope with deciduous trees, 29.10.2001, J. Nuytinck 2001-092 (GENT) – *ibid.*, 29.10.2001, J. Nuytinck 2001-093 (GENT) – **Morocco**, Lot. Mediouna, under *Pinus pinea*, 03.01.1959, G. Malençon 5905 (MPU) – Massif de Tamrabta, under *Pinus pinaster*, 21.11.1961, G. Malençon 5530 (MPU) – **Slovakia**, Botanical Institute, Bratislava, N48°10.256' E017°04.266', 260 m a.s.l., in lawn under *Pinus sylvestris*, 2.10.2001, J. Nuytinck 2001-044 (GENT) – Záhorská mžina lowland, 4 km SW of Moravsk'y Svatý ján village, on the river side of the Morava, N48°33.480' E016°56.978', 120-130 m a.s.l., *Pinus* forest on sand, under *Pinus sylvestris*, 2.10.2001, J. Nuytinck 2001-047 (GENT) – *ibid.*, 2.10.2001, J. Nuytinck 2001-048 (GENT) – Botanical Institute, Bratislava, N48°10.256' E017°04.266', 260 m a.s.l., in lawn under *Pinus sylvestris*, 3.10.2001, J. Nuytinck 2001-049 (GENT) – **Sweden**, Gotland, Viklau par., Tjaucklehagen 2km S viklau kyrka, in open grazed *Pinus* woodland, 13.10.1996, C. Lange, E. Bohus & P. Johansson, C. Lange 96-081 (GENT) – **Turkey**, Black sea region, under *Pinus*, 20.11.1997, A. Peksen & G. Hatat 220 (GENT) – Samsun district, Ondokuzmayis forestry service area, N41°30.106' E036°03.025', 27 m a.s.l., in mixed forest, under *Pinus nigra*, on calcareous soil, 20.10.2002, J. Nuytinck 2002-038 (GENT) – *ibid.*, N41°29.996' E036°02.911', 51 m a.s.l., in mixed forest, under *Pinus nigra*, on calcareous soil, 20.10.2002, J. Nuytinck 2002-039, 2002-040 (GENT) – Kocadag, N41°19.215' E036°07.660', 647 m a.s.l., mainly *Pinus* on slope, 22.10.2002, J. Nuytinck 2002-043 (GENT) – Malgölü-Alaçan, N41°40.806' E035°25.031', 12 m a.s.l., young *Pinus brutia* plantation, 25.10.2002, J. Nuytinck 2002-044 (GENT).

DISCUSSION: *L. semisanguifluus* is a small to medium-sized species, associated with *Pinus*, with bright orange latex turning wine red in 5 min. The pileus typically stains greenish, even in young basidiocarps. The spores in most studied collections are ornamented with a very incomplete reticulum, composed of isolated warts and some connective, fine ridges. Some variation in this pattern was observed however; some collections have spores with a more complete network (e.g. J. Nuytinck 2001-049) or with slightly thicker ridges (e.g. A. Verbeken 96-1032).

Neuhoff (1956), who described *L. deterrimus* as *L. semisanguifluus*, initially created confusion concerning the identities of both species. The mistake was adopted by several later authors (e.g. Favre 1960). Reil (1992) points out that the pileus never becomes deeply infundibuliform in *L. semisanguifluus* and that the context in the pileus margin is more thick and firm than in *L. deterrimus*.

L. sanguineovirescens was described in 1989 from the Savoie in south-east France (Fillion 1989). It is characterised by its greyish pileus with pink and buff shades, contrasting bright orange lamellae, orange latex turning red in 5 minutes, a greenish blue zone underneath the pileipellis and a distinctly acrid taste after some chewing; it

grows with *Pinus* on neutral to slightly acidic soil. In Romagnesi's opinion (1990) *L. sanguineovirescens* might be conspecific with *L. pinastri*. After sequencing collections identified as *L. sanguineovirescens* from near the type locality and after microscopical examination of the type material, we are convinced that *L. sanguineovirescens* is a synonym of *L. semisanguifluus* (Nuytinck & Verbeken 2005).

So far, "*L. sanguineovirescens*" has been reported from one other locality only (i.e. Sardinia, Melis et al. 1999). Examination of this material revealed that there are no microscopic differences with *L. quieticolor*. The picture in Melis et al. (1999) shows very dry basidiocarps (the pileipellis has become "metallic" and the lamellae show a strong discolouration to greenish blue).

10. *Lactarius vinosus* (Quél.→) Bataille, Fl. Monogr. Astérosporales: 28 (1908)

Fig. 11

- Synonyms: = *Agaricus deliciosus* var. *violaceus* Barla, Tableau comparatif des champignons comestibles et vénéreux de Nice tav. 4, fig. 24 (1855)
 = *L. sanguifluus* var. *vinosus* Quél., Compt. Rend. Assoc. Franç. Avancem. Sci. 9: 668 (1881 ("1880"))
 = *L. sanguifluus* var. *violaceus* (Barla) Basso, Fungi Europaei 7. *Lactarius* Pers.: 308 (1999)
 = *L. sanguifluus* f. *vinosus* (Quél.→Bataille) Lalli & Pacioni, Micol. Veg. Medit. 17 (2): 121-132 (2003)
 = *L. rubrozonatus* Lalli & Pacioni, Micol. Veg. Medit. 17 (2): 121-132 (2003)
 = *L. rubrozonatus* f. *carneus* Lalli & Pacioni, Micol. Veg. Medit. 17 (2): 121-132 (2003)
 ?= *L. deliciosus* var. *violascens* Panizzi, Comment. Soc. Crittog. Ital. 1: 174 (1862)
 ?= *L. sanguifluus* var. *yvreus* C. Martin, Bull. Trav. Soc. Bot. Genève 7: 184 (1894)
 ?= *L. haemorrhoeus* Lowe, Grevillea 16: 121 (1888)

Lectotype: Tableau comparatif des champignons comestibles et vénéreux de Nice: tav. 4, fig. 24! (Barla 1855), depicted from France, around Nice (**designated here**).

DESCRIPTION: *Pileus* 4–8 cm diam., at first convex with a decurved margin and a slightly depressed centre, later with a decurved to expanded margin and a depressed centre, sometimes slightly lobed-irregular, margin mostly regular; surface smooth, slightly viscid, becoming dry, typically distinctly zoned but sometimes only faintly zoned, sometimes scrobiculate; colour vinaceous red (7D6) with paler, more orange and/or darker zones, green where bruised, paler, discoloured forms rather common. *Lamellae* subdecurrent, medium broad, rather crowded, sometimes forked and often anastomosing near the stipe; colour pale violet (7A3) to vinaceous, strongly discolouring greenish where bruised; edge entire and slightly paler than the gills. *Stipe* 1.5–4.5 × 0.7–1.8 cm, clearly tapering downwards in most basidiomes; surface smooth, dry; colour brownish-red (10C4) but mostly strongly pruinose and then pinkish-violet, green where bruised, usually with numerous wine red (10E6) scrobicules of variable size. *Context* firm in the cap but hollow in the stipe, whitish buff in the central part of the stipe cavity, dark vinaceous red (11E/F5) in the entire pileus and near the stipe surface, turning greenish after several hours; smell faintly fruity; taste mild, shortly afterwards becoming very slightly bitter and slightly acid. *Latex* rather scarce, deep wine-red (11E/F5), drying

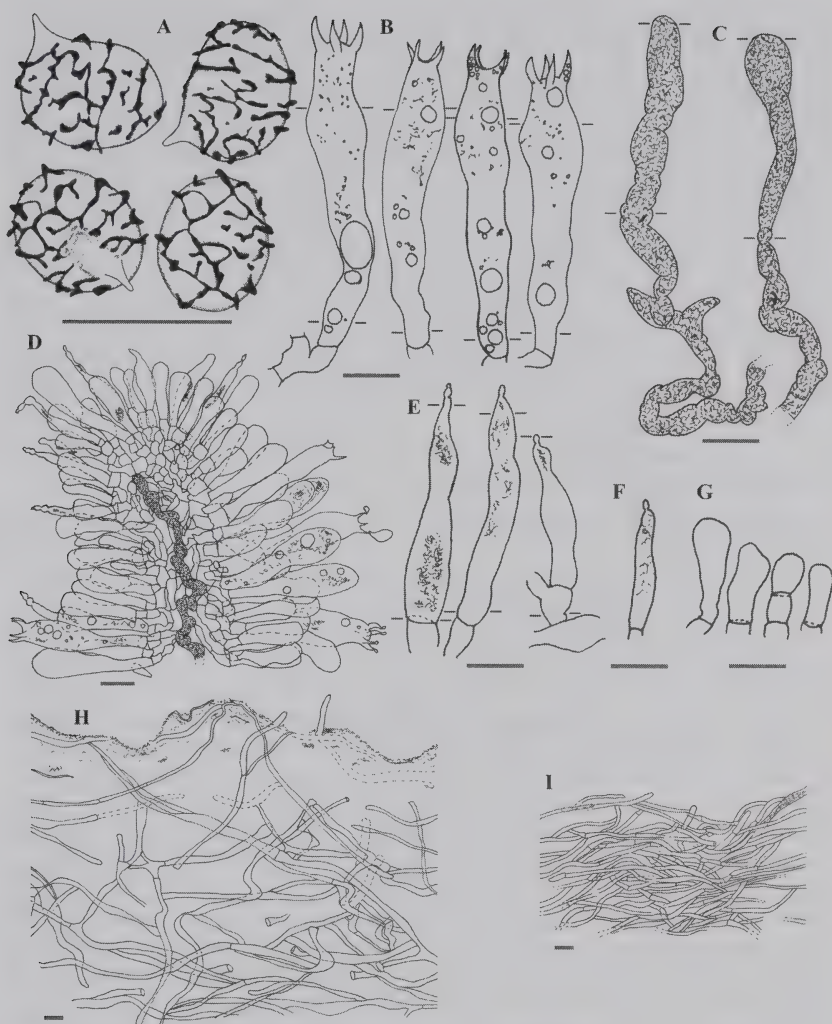


Fig. 11: *Lactarius vinosus*: A. spores; B. basidia; C. pseudocystidia; D. lamella edge; E. pleuromacrocystidia; F. cheilomacrocystidium; G. cheileptocystidia; H. section through the pileipellis; I. section through the stiptipellis. From M.T. Basso 961104 and J. Nuytinck 2001-104, 2001-122, 2003-058. Scale bars = 10 μm , small bars indicate the height of the hymenium.

brownish (8E8); taste mild. *Spore deposit* unknown.

KOH no reaction, *phenol* no reaction.

Spores $7.2\text{--}7.8\text{--}8.6\text{--}9.3 \times 5.6\text{--}6.1\text{--}6.7\text{--}7.4 \mu\text{m}$, subglobose to ellipsoid ($Q = 1.07\text{--}1.23\text{--}1.36\text{--}1.46$); ornamentation up to $0.5 \mu\text{m}$ high, of rather narrow ridges, forming an incomplete reticulum, scattered isolated warts and short ridges present; plage slightly

amyloid in the distal part. *Basidia* 45–60 × 9–11 µm, ± cylindrical to subclavate, 4-spored, often with abundant, oil-like droplets; sterigmata 4–6 µm long. *Pleuromacrocystidia* rather abundant, 35–55 × 6–9 µm, subfusiform to fusiform, tapering or moniliform at the apex, thin-walled. *Pseudocystidia* very abundant, 4–8 µm broad, not emergent to very slightly emergent, cylindrical to tortuous, with a refractive content. *Lamella edge* sterile with (quite) abundant cheilomacrocystidia; cheileptocystidia 7.5–25 × 4–8 µm, cylindrical to subclavate, hyaline or with a fine, granular content, thin-walled; cheilomacrocystidia 35–45 × 6–8 µm, fusiform, thin-walled. *Subhymenium* irregular, appearing like small, subglobose cell in rows under the hymenium elements. *Hymenophoral trama* irregularly filamentous; with abundant lactifers. *Pileipellis* an ixocutis, up to 200 µm thick, of frequently branching and interwoven hyphae, 2–6 µm diam., only few gelatinised or shrivelled, lactiferous hyphae present. *Stipitipellis* a cutis or ixocutis, 50–100 µm thick, of regularly shaped, strongly interwoven hyphae, 2–6 µm broad, no shrivelled nor gelatinized hyphae, sometimes with very abundant lactifers. *Clamp-connections* absent.

HABITAT: Associated with *Pinus*, on calcareous soils but presumably less strictly than *L. sanguifluus*, mainly found in late autumn.

DISTRIBUTION: Mediterranean (distribution more southern than *L. sanguifluus*), also known from Turkey.

COLLECTIONS EXAMINED: **Italy**, Toscana, Marina de Grosseto, Pineta sul Mare, 4.11.1996, leg. D. Maggiori, M.T. Basso 961104 – **Spain**, Surroundings of St Hilary Sacalm, 6.11.2001, leg. G. Gulden, J. Nuytinck 2001-104a+b+c (GENT) – Ermita Sart Ponç (Tordera), N41°42'56.6" E002°40'25.6", 3 m a.s.l., 7.11.2001, J. Nuytinck 2001-116 (GENT) – St Hilary Sacalm, 7.11.2001, J. Nuytinck 2001-122 (GENT) – Close to Fuenteheridos, region of Aracena, N37°54.195' W006°40.846', 690 m a.s.l., Under *Pinus pinaster*, 4.11.2003, J. Nuytinck 2003-050 – Between Linares de la Sierra and Alajar, N37°52.789' W006°38.792', 685 m a.s.l., Under *Pinus pinea*, 6.11.2003, leg. L. Llorens, J. Nuytinck 2003-058 – **Turkey**, Samsun, under *Pinus*, 26.11.1997, A. Peksen and G. Hatat 230 (GENT) – Samsun district, Ondokuzmayis forestry service area, N49°02'25.4" E011°12'76.1", 29 m a.s.l., in mixed forest, under *Pinus nigra* on calcareous soil, 20.10.2002, J. Nuytinck 2002-037 (GENT).

DISCUSSION: *L. vinosus* has a striking violet-red to deep vinaceous red overall tinge. The cap is generally zonate, the tapering stipe is strongly pruinose and mostly scrobiculate. There is a strong tendency to discolouring greenish after bruising or picking of the fruiting bodies. The latex is vinaceous red from the beginning.

L. vinosus and *L. sanguifluus* are very close relatives (Nuytinck & Verbeken 2005) but there are some striking differences between the typical representatives of both. Macroscopically the colour of the cap, stipe and lamellae is more vinaceous red in *L. vinosus*, which is almost completely lacking orange tinges. This is in accordance with the oldest descriptions of *L. vinosus* (Barla 1859, Quélet 1881) and contradicts the opinion of Marxmüller & Romagnesi (1991). Possibly their concept of *L. vinosus* refers to a pale form of *L. sanguifluus*, but we had none of their collections available to check this. The stipe is more distinctly tapering downwards in *L. vinosus* and the latex colours the context of the cap more intensely and completely. Microscopically, the reticulum on the spores of *L. vinosus* is less complete and less dense than in *L. sanguifluus*. In *L. sanguifluus* the ridges are more regular and evenly thick, while in *L. vinosus* they are

locally thinner. Discoloured forms of both species, complicating the identification, are often observed however.

Some confusion exists about the correct epitheton and authority of *L. vinosus*. The oldest known reference to *L. vinosus* is from Barla (1855): a drawing of half a fruiting body with the name *Agaricus deliciosus* var. *violaceus*. This publication is effective and valid (art. 29 & 44 ICBN, Greuter et al. 2000). A description was given in a later work of Barla (1859) without reference to the earlier drawing. Although it is hard to be sure on the basis of one drawing and a short description, we interpret Barla's *Agaricus deliciosus* var. *violaceus* as the same as *L. vinosus* (in the sense of most current authors). The description (Barla 1859) contains several indications that Barla indeed had *L. vinosus* in mind. The colour of the fruiting body is described as violet-red, even from the beginning, with the lamellae having the same tint or even more pronounced, more bright. The stipe is described as short, tapering downwards and pruinose, whitish. It is described as a species fruiting slightly later in the year, when the first frosts are nearing. These are all typical features of *L. vinosus*. Quélet (1881) explicitly refers to the work by Barla but changes the epitheton from *violaceus* to *vinosus* (*Lactarius sanguifluus* var. *vinosus*). Quélet's name is thus an illegitimate nomenclatural synonym (art. 52 ICBN, Greuter et al. 2000). Bataille (1908) is the first author to use the epitheton *vinosus* on species level (although the rank Bataille used is disputable). Even though its basionym is illegitimate, this combination has to be considered as a legitimate nom. nov. (art. 58 ICBN, Greuter et al. 2000) and thus the name *L. vinosus* has to be used for this taxon on species level (art. 11.2 ICBN, Greuter et al. 2000). The correct author citation, taking into consideration art. 46.3 ICBN (Greuter et al. 2000) is thus *L. vinosus* Bataille, or *L. vinosus* (Quélet →) Bataille, as proposed by Kuyper & Van Vuure (1985) to refer to a replaced illegitimate name that typifies the newly created name. Lalli et al. (2003) interpret *Agaricus deliciosus* var. *violaceus* Barla as identical to *L. sanguifluus*, and argue that if Barla had known *L. sanguifluus* he would have made his var. *violaceus* subordinate to the latter. They do not find a discriminating character between *Agaricus deliciosus* var. *violaceus* and *L. sanguifluus* in the later description (Barla 1859). In the description of Quélet (1881, 1888), who explicitly refers to Barla (1855) and produces only a simple interpretation of his drawing, they interpret *L. sanguifluus* var. *vinosus* as a discoloured form of *L. sanguifluus*. Strengthened by Marxmüller & Romagnesi's (1991) concept of *L. sanguifluus* var. *vinosus*, they propose the new name *L. rubrozonatus* for what we call *L. vinosus* in this work. Furthermore they describe *L. rubrozonatus* f. *carneus* for the paler, discoloured forms.

Several old publications describe taxa that correspond also well to *L. vinosus*, *L. sanguifluus* or a discoloured form of them; no type specimens were indicated and no certainty exists about their identity:

Panizzi (1862) describes *Lactarius deliciosus* var. *violascens* from the region of Baiardo (Imperia, Italy). The description corresponds best to *L. vinosus*: the cap is zonate, the stipe is 'subconicus', whitish-violet and pitted, the lamellae are 'livido-violascentes'. This taxon could maybe also correspond to a form of *L. sanguifluus*: the cap colour is described as pale orange.

L. sanguifluus var. *yvreus* C. Martin seems to be very similar in every aspect to a discoloured form of *L. vinosus*. Martin (1894) thinks var. *yvreus* is different from *L. sanguifluus* because it often has a hollow stipe which is amethyst coloured and not

reddish-orange and because the lamellae have an amethyst sheen and are never cream to pinkish-orange. He also mentions this taxon is very close to Barla's var. *vinosus*.

From the short description of *L. haemorrhæus* (Lowe in Cooke 1888), collected in Madeira, we can only decide that this taxon must also correspond to a form of *L. sanguifluus* or *L. vinosus*.

Insufficiently known and doubtful taxa from Europe

All names that are listed here are considered doubtful, insufficiently known or could not with certainty be synonymised with one of the well-known taxa.

aeruginosus. *Lactarius deliciosus* var. *aeruginosus* E. Bommer & M. Rousseau, Bull. Soc. Roy. Bot. Belgique 18: 94 (1879), nom. inval., nom. nud.

Bommer & Rousseau (1879) mention 'sous les sapins entre Boisfort et Auderghem. Août-septembre' for this variety, without further description. No type was designated.

atrovirens. *Lactarius deliciosus* var. *atrovirens* J. Blum, Lactaires: 217 (1976)

This variety is described as very small and deep green in the pileus, stipe and lamellae from the beginning. The type is missing from PC. Given the fact that many *Deliciosi* species start as deep blue-green buttons, it is hard to draw any further conclusions. This name should be treated as a nomen dubium.

flammeolus. *Lactarius flammeolus* (Pollini: Fr.) Fr., Epicr. Syst. Mycol.: 341 (1838)

≡ *Agaricus flammeolus* Pollini, Giorn. Fis. 9: 34 (1816)

See under *L. salmonicolor*.

haemorrhæus. *Lactarius haemorrhæus* Lowe, Grevillea 16: 121 (1888)

See under *L. vinosus*.

rubrifluus. *Lactarius rubrifluus* Gillet, Bull. Soc. Linn. Normandie II 4: 255 (1870)

Gillet describes *L. rubrifluus* very elaborately, especially when considered the early time of publication, but no type material was selected. Unfortunately we cannot decide from his description with which currently used name *L. rubrifluus* coincides. The description bears much resemblance with *L. deterrimus* and *L. semisanguifluus* but two key characters are lacking to decide upon the identity: the host species ('sous sapins' was used for any coniferous tree) and the rate at which the colour of the latex changes. This taxon was subject for debate several times. Schaefer (1970) interpreted the description as *L. pinicola* (= *L. deliciosus* sensu most current authors). Romagnesi (1958), Gröger (1968) and Basso (1999a) share the same opinion and stay inconclusive about eventual synonymy with *L. deterrimus* or *L. semisanguifluus*. We consider *L. rubrifluus* a nomen dubium for the sake of nomenclatural stability.

violaceocaeruleus. *Lactarius violaceocaeruleus* Voglino, Boll. Soc. Bot. Ital. 1894: 122 (1894)

This very remarkable find by Voglino (1894) under *Castanea* (!?) is described as having a violet-blue cap, abundant blue milk and blue coloured lamellae. According to Singer (1942) it is identical to *L. indigo*. As Schaefer (1970) already indicates, this is probably not true as the stipe in *L. violaceocaeruleus* is pale ochre-yellow and the cap is not zonate and violet-blue coloured and thus different from *L. indigo*. The description by Voglino also reminds of the very recently described *L. cyanopus*. Basso (1999a) writes that *L. cyanopus* differs from *L. violaceocaeruleus* by the habitat, the colour of the cap and lamellae, and the colour of the latex that is only partially blue in *L. cyanopus*.

violascens. *Lactarius deliciosus* var. *violascens* Panizzi, Comment. Soc. Crittog. Ital. 1: 174 (1862)

See under *L. vinosus*.

yvreus. *Lactarius sanguifluus* var. *yvreus* C. Martin, Bull. Trav. Soc. Bot. Genève 7: 184 (1894)

See under *L. vinosus*.

Excluded taxa

L. deliciosus var. *tenuis* Naveau, Natuurw. Tijdschr. 5: 70 (1923)

Holotype: BR-130746,87 (BR!), Belgium: Peerdsbos (Herentals, near Antwerpen)

Spores ellipsoid, $\sim 7.5 \times 6 \mu\text{m}$ ($Q = 1.30$); ornamentation clearly deformed with rounded, droplet-like warts, breaking off easily, warts $1 \mu\text{m}$ high and higher, connected by fine, low and often unclear ridges.

COLLECTIONS EXAMINED: **Belgium**, Peerdsbos (Herentals, near Antwerp), Muscinetum under *Fagus*, 26.09.1920, R. Naveau, BR-130746,87 (BR), holotype.

DISCUSSION: Although the type material is deformed (probably by age) we exclude the possibility that this taxon belongs to *Lactarius* sect. *Deliciosi*. The spores are too small for *L. deliciosus*. This taxon could belong to *Lactarius* sect. *Zonarii* or sect. *Piperites*.

Acknowledgements

The curators of the herbaria BR, LIP, MPU & PC and P.A. Moreau & M. Contu are thanked for providing herbarium material. We would also like to thank M.T. Basso, A. Gminder, J. Heilmann-Clausen, P.J. Keizer, C. Lange, M.A. Pérez-De-Gregorio, J. Vesterholt, R. Walley and all other collectors listed in the examined specimens lists. Ruben Walley is thanked for the help with the nomenclature and Chiel Noordeloos is thanked for the review. The research of the first author is financed by the Institute for the Promotion of Innovation by Science and Technology in Flanders (IWT), Belgium.

Literature cited

- Agerer R. 1986. Studies on Ectomycorrhizae III. Mycorrhizae formed by four fungi in the genera *Lactarius* and *Russula* on Spruce. Mycotaxon 27: 1-59.
- Barla JB. 1855. Tableau comparatif des champignons comestibles et vénéreux de Nice, Nice.
- Barla JB. 1859. Les champignons de la province de Nice et principalement les espèces comestibles, suspectes ou vénééuses, dessinés d'après nature, Nice.
- Basso MT. 1998. *Lactarius cyanopus* une nouvelle espèce de la sect. *Dapetes* Fries. Bull. Trimestriel Soc. Mycol. France 114: 67.
- Basso MT. 1999a. *Lactarius* Pers. Fungi Europei, VIII, Mycoflora, Alassio.
- Basso MT. 1999b. Description et étude de *Lactarius cyanopus* Basso. Bull. Trimestriel Soc. Mycol. France 115: 57-64.
- Bataille F. 1908. Flore monographique des Astérosporés, Lactaires et Russules. Mém. Soc. Emul. Doubs 8: 163-260.
- Bergendorff O, Sterner O. 1988. The sesquiterpenes of *Lactarius deliciosus* and *L. deterrimus*. Phytochemistry 27: 97-100.
- Bertault R. 1978. Lactaires du Maroc. Bull. Trimestriel Soc. Mycol. France 94: 273-288.
- Blum J. 1976. Etudes mycologiques III. Les lactaires. Paris, Lechevalier, 371 pp.
- Bon M. 1975 («1973»). Macromycètes du Nord de la France. Rev. Mycol. (Paris) 38: 185-206.
- Bon M. 1980. Clé monographique du genre *Lactarius*. Doc. Mycol. 10 (40): 1-85.
- Bresadola G. 1929. Iconographia Mycologica 8: pl. 351-400, Milano.
- Britzelmayer M. 1885. Hymenomyceten aus Südbayern 4 (Die Hymenom. Augsburgs und seiner

- Umgebung), Naturhist. Verein. Augsburg 28: 119-160.
- Cléménçon H. 1972. Zwei verbesserte Präparierlösungen für die mikroskopische Untersuchung von Pilze. Z. Pilzk. 38: 49-53.
- Cooke MC. 1888. New British Fungi. Grevillea 16: 121.
- Courtecuisse R, Duhem B. 1994. Les champignons de France. Delachaux et Niestlé, Eclectis, Lausanne.
- den Bakker HC, Zuccarello GC, Kuyper ThW, Noordeloos ME. 2004. Evolution and host specificity in the ectomycorrhizal genus *Leccinum*. New Phytol. 163: 201-215.
- Eberhardt U. 2000. Moleculare Analysen zur Verwandtschaft der agaricoiden Russulaceen im Vergleich mit Mykorrhiza- und Fruchtkörpermerkmalen. PhD thesis, University of Tübingen.
- Eberhardt U, Oberwinkler F, Verbeke A, Rinaldi AC, Pacioni G, Comandini O. 2000. *Lactarius* ectomycorrhizae on *Abies alba*: morphological description, molecular characterisation, and taxonomic remarks. Mycologia 92: 860-873.
- Favre J. 1960. Catalogue descriptif des champignons supérieurs de la zone subalpine du Parc national Suisse. Luding A.G., 272 p.
- Fillion R. 1989. Un nouveau Lactaire du groupe *Dapetes* découvert dans la région de Clarafond: *Lactarius sanguino-virescens* nov. sp. Bull. Trimestriel Féd. Mycol. Dauphiné-Savoie 113: 20-22.
- Floriani M. 1999. Alcuni *Lactarius* «nordici» raccolti in Trentino. Pag. Micol. 12: 83-93.
- Fries EM. 1821. Systema Mycologicum. Vol. I. Greifswald. 520 pp.
- Fries EM. 1838. Epicrisis Systematis Mycologici seu Synopsis Hymenomycetum. Uppsala. 610 p.
- Fries EM. 1861. Sveriges ätliga och giftiga svampar, Stockholm.
- Gramberg E. 1921. Pilze der Heimat, Leipzig.
- Greuter W, McNeill J, Barrie FR, Burdet H-M, Demoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Treharne P, Turland NJ, Hawksworth DL. 2000. International Code of Botanical Nomenclature (St Louis Code). Regnum Vegetabile 138. Koeltz Scientific Books, Königstein.
- Gröger F. 1968. Zur Kenntnis von *Lactarius semisanguifluus* Heim & Leclair. Westfäl. Pilzbriefe 7: 3-12.
- Heilmann-Clausen J, Verbeke A, Vesterholt J. 1998. The genus *Lactarius*. Fungi of Northern Europe 2. Svampetryk, Denmark.
- Heim R, Leclair A. 1950. Notes systématiques sur les Champignons du Perche. II. Les Lactaires à lait rouge (Stirpe deliciosus). Rev. Mycol. (Paris) 15: 65-78.
- Heim R. 1954 ("1953"). A propos des Lactaires à lait rouge. Rev. Mycol. (Paris) 18: 221-224.
- Hesler LR, Smith AH. 1979. North American species of *Lactarius*. Ann Arbor, University of Michigan Press. 841 pp.
- Korhonen M. 1984. Suomen rouskut. Otava, Helsinki. 223 pp.
- Körnerup A, Wanscher JH. 1962. Farver i Farver. Politikens Forlag, Copenhagen.
- Kriegelsteiner GJ. 1991. Über neue, seltene, kritische Macromyzeten in Westdeutschland XII. Röhrlinge und Blätterpilze. Beitr. Kenntn. Pilze Mitteleurop. 7: 61-79.
- Krombholz JV. 1831-1846. Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme. Praga.
- Kuyper ThW, Van Vuure M. 1985. Nomenclatural notes on *Russula*. Persoonia 12: 447-455.
- Lalli G, Pacioni G. 2003 ("2002"). Neotipificazione di *Lactarius sanguifluus* e descrizione di *Lactarius rubrozonatus* sp. nov. Micol. Veg. Medit. 17: 121-132.
- Lange JA. 1940. Flora Agaricina Danica 5, Copenhagen, 105 pp. and 39 plates.
- Linnaeus C. 1753. Species Plantarum. Holmiae.

- Martin C. 1894. Title unknown, concerning a check-list that mentions *Lactarius sanguifluus* var. *yvrens*. Bull. Trav. Soc. Bot. Genève 7: 184.
- Marxmüller H, Romagnesi H. 1991. *Lactarius sanguifluus* (Paulet: Fr.) Fr. var. *vinosus* Quélet. Bull. Trimestriel Soc. Mycol. France 107: 5-6. Atlas, Pl. 262.
- Melis M, Mua A, Campus G. 1999. Funghi interessanti della Sardegna. Contributo alla conoscenza di una rara specie: *Lactarius sanguineo-virescens*. Micol. Veg. Medit. 14: 142-146.
- Michael E. 1895-1905. Führer für Pilzfreunde: Bd. 1-3.
- Michael E. 1927. Führer für Pilzfreunde, systematische geordnet und gänzlich neu bearbeitet von Roman Schulz.
- Montoya L, Bandala VM, Herrera S, Ortíz J. 1998. An interesting record of *Lactarius* from the Gulf and Caribe. Z. Mykol. 64: 91-96.
- Münzenberger B, Metzler B, Kottke I, Oberwinkler F. 1986. Morphologische und anatomische Charakterisierung der Mykorrhiza *Lactarius deterrimus-Picea abies* in vitro. Z. Mykol. 52: 407-422.
- Neuhoff W. 1956. Die Milchlinge (Lactarii). In Die Pilze Mitteleuropas Bd. Iib. Julius Klinckhardt, Bad Heilbrunn. 248 pp.
- Nuytink J, Verbeken A. 2003. *Lactarius sanguifluus* versus *Lactarius vinosus* molecular and morphological analyses. Mycol. Progr. 2: 227-234.
- Nuytink J, Verbeken A. 2005. Species delimitation and phylogenetic relationships in *Lactarius* sect. *Deliciosi* (*Russulales*) in Europe. Mycol. Res.: accepted.
- Nuytink J, Verbeken A, Miller SL. 2005. Worldwide phylogeny of *Lactarius* sect. *Deliciosi* inferred from ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences: in preparation.
- Panizzi F. 1862. Degli Imenomiceti che crescono nel Circondario di San Remo. Comment. Soc. Crittog. Ital. 3: 166-175.
- Paulet JJ. 1811. Traité des champignons: 2 (9ed). Paris.
- Peck CH. 1898. Contributions of the Alabama biological survey. 1. New species of Alabama fungi. Bull. Torrey Bot. Club 25: 368-372.
- Pérez-De-Gregorio MA, Carbó J. 2004. *Lactarius cyanopus* Basso. Lamina 1126. In Bolets de Catalunya 23, Societat Catalana de Micologia.
- Pilát A. 1951. Klíč určování našich hub hřibovitých a bedlovitých, Praha.
- Pilát A, Ušák O. 1951. Naše houby 1, Praha.
- Pillukat A. 1996a. *Lactarius salmonicolor*. In Colour Atlas of Ectomycorrhizae, plate 122, Agerer R. (Ed.) Einhorn-Verlag, Schwäbisch Gmünd.
- Pillukat A. 1996b. *Lactarius salmonicolor*. In Descriptions of Ectomycorrhizae 1: 59-64, Agerer R., Danielson RM., Egli S., Inleby K. Luoma D., Treu R. (Eds.) Einhorn-Verlag, Schwäbisch Gmünd.
- Pollini C. 1816. Horti et provinciae Veronensis plantarum novarum vel minus cognitarum descriptio. Giorn. Fis. 9: 21-35, 94-101, 174-187.
- Pouzar Z. 1954. Poznamky k nekterym nasim druhum ryzcu - Lactarius I. Česká Mykol. 8: 40-45.
- Quélet L. 1880. Quelques espèces critiques ou nouvelles de la flora mycologique de France. Compt. Rend. Assoc. Franç. Avancem. Sci., Suppl. 10: 7-8.
- Quélet L. 1881. Quelques espèces critiques ou nouvelles de la flora mycologique de France. Compt. Rend. Assoc. Franç. Avancem. Sci. Congrès de Reims 1880. 9: 661-675.
- Quélet L. 1888. Flore mycologique de la France et des pays limitrophes. Paris, Doin. 492 pp.
- Quélet L. 1893. Quelques espèces critiques ou nouvelles de la flora mycologique de France.

- Compt. Rend. Assoc. Franç. Avancem. Sci., Suppl. 19: 487.
- Reil P. 1992. Die rotmilchende Reizker. Südwestdeutsche Pilzrundschaу 28: 2-8.
- Romagnesi H. 1958. Recherches sur les Lactaires à lait rouge (*Dapetes* Fr.). Rev. Mycol. (Paris) 23: 261-281.
- Romagnesi H. 1990. À propos de *Lactarius sanguineo-virescens* Fillion. Bull. Trimestriel Féd. Mycol. Dauphiné-Savoie 116: 35.
- Schaefer Z. 1970. Beitrag zum Studium der Milchlinge. Sektion *Dapetes*. Schweiz. Z. Pilzk. 48: 105-143.
- Schaeffer JC. 1762-1774. Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur, 4 vol.
- Schmitt JA. 1974. Chemotaxonomische, morphologische und pflanzensoziologische Studien an Mitteleuropäischen *Lactarius*-Arten der Sektion *Dapetes* Fr. (Blutreizker). Z. Pilzk. 39: 219-244.
- Singer R. 1942. Das System der Agaricales. Ann. Mycol. 40: 115.
- Smotlacha F. 1947. Atlas hub jedlých a nejdýlk (Atlas of edible and poisonous fungi). Melantrich (Ed.), Praha.
- Strid A. 1994. A catalogue of fungus plates painted under the supervision of Elias Fries. Swedish Museum Nat. Hist., Stockholm.
- Treu R. 1990. Charakterisierung und Identifizierung von Ektomykorrhizen aus dem Nationalpark Berchtesgarden. Bibl. Mycol. 134: 1-196.
- Uhl M. 1988. Identifizierung und charakterisierung von ektomykorrhizen an *Pinus sylvestris* und ectomycorrhizen aus der gattung *Tricholoma*. PhD thesis, Ludwig-Maximilians-Universität München.
- Vassilkov BP. 1948. Sedobnyje i jadovityje griby srednej polosy evropejskoj časti SSSR [Edible and poisonous fungi of central parts Europ. distr. U.S.S.R.], Moscow-Leningrad.
- Verbeken A, Vesterholt J. 1998. A new *Lactarius* species from Scandinavia in the section *Dapetes*. Cryptog. Mycol. 19: 87-91.
- Voglino P. 1894. Osservazioni micologiche: Notizie intorno ad alcuni funghi raccolti ne'dintorni di Busalla e Ronco. Boll. Soc. Bot. Ital.: 115-122.

***Aseroë floriformis*, a new phalloid with a sunflower-shaped receptacle**

I. G. BASEIA¹ & F. D. CALONGE²

ibaseia@bol.com.br

¹Universidade Federal do Rio Grande do Norte, CB

·Depto. Botânica, Ecologia e Zoologia, Natal, RN, Brazil. 59072-970

calonge@ma-rjb.csic.es

²Real Jardín Botánico, CSIC

Plaza de Murillo 2, 28014 Madrid, Spain

Abstract — *Aseroë floriformis* represents a new species lacking radiating branches on the receptacle and having a raspberry colour on the stipe; it grows in sandy soil.

Key words — *Phallales*, *gasteromycetes*, taxonomy, neotropics, Brazil

Introduction

The gasteroid fungi of northeastern Brazil are the subject of on-going collecting activities, the results of which have led to some interesting discoveries (Baseia & Galvão 2002, Baseia & Milanez 2002, Baseia et al. 2003, Baseia 2003).

The genus *Aseroë* was proposed by Labillardière (1806) for a single species, *A. rubra* Labill. A second species, *A. arachnoidea* E. Fisch., was described by Fischer (1890) and a potential third by Imazeki & Yoshimi (1989), who introduced the name *A. coccinea* Imazeki & Yoshimi (nom. inval., Art. 36.1; as “ad interim”). However, the Index Fungorum includes 27 names assigned to this genus although these have been shown to represent only two species, *A. rubra* and *A. arachnoidea*, following the excellent revision carried out by Dring (1980). The large variability of the morphology of the basidioma led to this proliferation of names where 25 were shown to be synonyms of the most frequently encountered *A. rubra* (Dring 1980).

Only these two species are accepted in the last edition of the Dictionary of the Fungi (Kirk & al. 2001). Both species can be distinguished by basidioma composed of a receptacle and a well-differentiated sterile, hollow, cylindrical stipe arising from a white volva. The two species have branches attached to the margin of the receptacle and the gleba is located on the upper surface of the disc, branches or both (Dring 1980). They present a pantropical distribution (Dring 1980), with a possibility of expansion through other regions, an example being *A. rubra*, which has been found naturalized in Europe (Spooner 1994).

Material and Methods

Material Examined — Collecting expeditions were conducted during June and July 2004, to the Parque Estadual Dunas do Natal (05°46' S and 35°12' W) and Reserva Particular do Patrimônio Natural Mata Estrela (06°22'10" S and 35°00'28" W), both are remnants of the Atlantic rain forest located in the State of Rio Grande do Norte.

Methods — Basidiomata were examined and photographed in the field. Colours were coded according to Kornerup & Wanscher (1978), with the indication “KW”, bracketed in the text, and simultaneously described. They were dried slowly and placed in containers with naphthalene, to prevent destruction by deteriogens. In addition, some basidiomata were stored fresh in FAA.

Results

Aseroë floriformis Baseia & Calonge, sp. nov. (Fig. 1)

Etymology: floriformis, due to its resemblance to a flower.

Ovo subglobose, 15–20 mm diametro, epigaeo, albo-aureo. Stipite cylindrico, spongioso, rubro-roseolo, 30–40 mm alto, 5–8 mm lato. Receptaculo floriforme, rubro-roseolo, 15–35 mm diametro, cum disco centralis perforatus, robromarginatus, sine ramulis, cum gleba gelatinosa, griseo-brunnea, foetida. Sporis cylindraceo-bacilliformis, 4–6 (–7) × 1.5–2 µm, laevis, hyalinis.

Holotypus: Brasil, Rio Grande do Norte, Parque das Dunas, ad solum arenarius, 3-VII-2004, legit I. G. Baseia et P. P. T. Lacerda, UFRN 1851. **Isotypus:** URM 78650 et MA-Fungi 59460.

Egg subglobose, 15–20 mm diam, epigeal, white yellowish (4A3), mycelial cords robust, white. **Volva** composed of an internal, hyaline, gelatinous layer and a membranous structure, made of hyaline, septate, branched hyphae, 3–7 µm diam. **Stipe** cylindrical, spongy, reddish (11A6) to pink (11A4), 30–40 mm high, 5–8 mm wide, with a pseudoparenchymatous structure made of globose elements, 12–45 µm diam, with intracellular pigment. **Receptacle** with the same anatomy, sunflower-shaped, 15–35 mm diam, without branches or any vestiges of them, pinkish (11A4), central disc perforate, showing a reddish edge (11A8), covered by the gelatinous gleba, of a grey brownish colour (11F1). **Spores** cylindrical to bacilloid, 4–6 (–7) × 1.5–2 µm, smooth, hyaline. When fresh it produces a repellent odour, reminiscent of cow dung.

Key to the species of *Aseroë*

- 1. Receptacle with branches 2
- 1. Receptacle without branches. *A. floriformis*
- 2. Receptacle white, branches consisting of a single tube *A. arachnoidea*
- 2. Receptacle red, branches composed of several chambers *A. rubra*

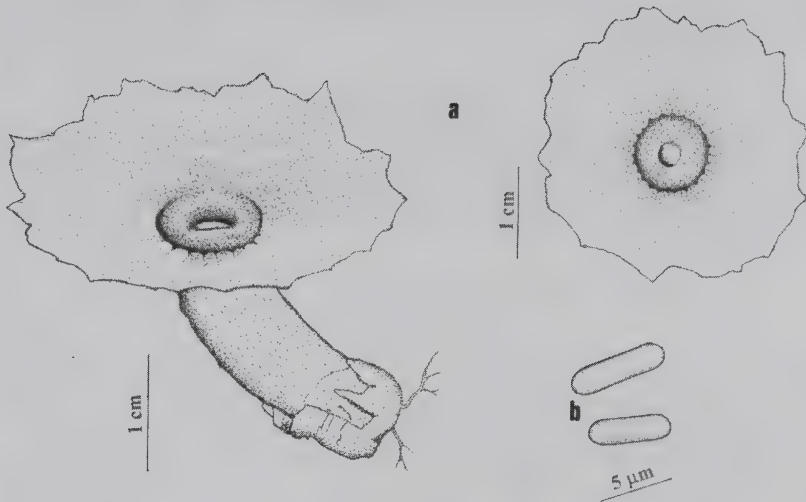


Fig. 1 *Aseroë floriformis* UFRN 1851, Holotypus. **a:** mature badiomata. **b:** basidiospores.

Discussion

There are two species of *Aseroë*: *A. rubra*, with a pantropical distribution, reddish receptacle bearing branches in pairs and with each branch composed of several chambers, and *A. arachnoidea*, from Asia and West Africa, distinguished by its white receptacle, with individual branches consisting of a single chamber (Fischer 1933).

Concerning phylogenetic relationships, Dring (1980) concluded that it was difficult to establish real links between *A. rubra* and *A. arachnoidea*. The same is true when *A. floriformis* is added. This new species appears to be close to *A. rubra* when comparing several features; the colour and shape of the basidioma, and the size and shape of the spores which are bacilloid in both species in contrast to the ellipsoid to ovoid spores of *A. arachnoidea* (Dring 1980).

Aseroë rubra usually has bifurcate branches, but this is not always the case. Specimens without bifurcate branches have also been found (Dring 1980), which may have suggested that a division of the species into two taxa was justified. However, considering the many names included in synonymy, it is not prudent to propose this division until more evidences, both from field studies and molecular biology, are available and results from an analysis thereof provides the justification.

The taxonomy of the genus *Aseroë* is far from being fully understood. Thus, more studies on the ecology, phylogeny, anatomy and biochemistry of the included species are needed.

Finally, the three species keyed above share a tropical distribution. *A. rubra*, however, appears to be naturalised in Europe (Spooner 1994). In conclusion, after a complete

literature review of the genus *Aseroë*, we concluded that the lack of branches on the receptacle and habitat of growing on sand of dunes, justify the introduction of a new species, *A. floriformis*.

Acknowledgments

We express our sincere gratitude to Prof. Hanns Kreisel, to Prof. Gabriel Moreno and Dr. María P. Martín for their valuable comments and taxonomic advice. Thanks are also given to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support; and to Tereza Cristina de Oliveira Galvão for the illustrations. We wish to thank Dr. P. M. Kirk for the correction of the English text.

References

- Baseia IG. 2003. Contribution to the study of the genus *Calvatia* (*Lycoperdaceae*) in Brazil. *Mycotaxon* 88: 107-112.
- Baseia IG, Galvão TCO. 2002. Some interesting Gasteromycetes (Basidiomycota) in dry areas from Northeastern Brazil. *Acta Bot. Bras.* 16: 1-8.
- Baseia IG, Gibertoni TB, Maia LC. 2003. *Phallus pygmaeus*, a new minute species from a Brazilian tropical rain forest. *Mycotaxon* 85: 77-79.
- Baseia IG, Milanez AI. 2002. *Gastrum setiferum* (Gasteromycetes): a new species with a setose endoperidium. *Mycotaxon* 84: 135-139.
- Dring DM. 1980. Contributions towards a rational arrangement of the *Clathraceae*. *Kew Bull.* 35: 1-96.
- Fischer E. 1890. *Denkschr. Schweiz. Ges. Nat.* 32: 76.
- Imazeki R, Yoshimi S. 1989. *Colour Illustrations of Mushrooms of Japan*. Vol. 2, Osaka, Hoikusha: 218.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edition, CABI Int. Publ.
- Kornerup A, Wanscher JH. 1978. *Methuen handbook of colours*. Third edition. Eyre Methuen. London. 252 pp.
- Labillardière JH. 1806. *Novae Hollandiae Plantarum Specimen*. Vol. 2: 124.
- Spooner B. 1994. *Aseroë rubra* at Oxshott. *Mycologist* 8: 153.

***Exserohilum heteromorphum* sp. nov.,
a new helminthosporioid fungus
from *Echinochloa* in China**

GUANGYU SUN, RONG ZHANG, WANG ZHOU & MINGQI ZHU

sunguang@public.xa.sn.cn

*College of Plant Protection, Northwest A & F University
Yangling, Shaanxi, 712100, China*

Abstract — *Exserohilum heteromorphum* sp. nov. is described and illustrated on *Echinochloa crusgalli* var. *mitis* from China. It is compared with other closely related species in the genus.

Key words — Hyphomycetes, taxonomy, new species

Introduction

During investigations of helminthosporioid fungi in China, an *Exserohilum* species was found on *Echinochloa crusgalli* (L.) Beauv. var. *mitis* (Pursh) Peterm. It could not be assigned to any of the described species and is treated herein as new. The genus *Exserohilum* was established to segregate those species with a protruding conidial hilum, which previously had been accommodated in *Bipolaris* Shoem. or *Drechslera* Ito sens. lat. (Leonard & Suggs, 1974). Leonard and Suggs (1974) accepted eight *Exserohilum* species. Subsequently more species were published. To date, about 30 *Exserohilum* species have been proposed (Alcorn 1988, 1991; Castañeda, Guarro & Cano 1995; Del Serrone, Porta-Puglia & Sivanesan 1991; Guiraud et al. 1997; Sivanesan, 1987, 1992; Sivanesan, Abdullah & Abbas, 1993; Steiman et al. 2000; Sun et al. 1997; Upadhyay & Mankau 1991; Wu 1990). There are currently eight species of *Exserohilum* reported from China, namely, *E. frumentacei* (Mitra) Leonard & Suggs, *E. monoceras* (Drechsler) Leonard & Suggs, *E. rostratum* (Drechsler) Leonard & Suggs, *E. turcicum* (Pass.) Leonard & Suggs (Tai 1979), *E. holmii* (Luttr.) Leonard & Suggs (Peng & Lu 1989), *E. fusiforme* Alcorn (Sun et al. 1996), *E. longisporum* G. Y. Sun (Sun et al. 1997) and *E. phragmitis* Wu (Wu 1990).

Materials and Methods

Infected plant leaf surfaces were washed in running water and incubated in moist chambers at 25 (±1)°C. The incubated leaves were observed under the stereo microscope 2 days later, and single spore isolations were carried out (Sun & Zhang, 1996). Single spore isolates were then transferred to potato dextrose agar (PDA) and tap water agar with autoclaved wheat straw (TWA + W) plates and exposed to light on a 12 h diurnal

cycle at 25 ($\pm$ 1) $^{\circ}$ C. The morphological description of the species is based on 10-14 d cultures on TWA + W. Measurements and photographs of fungal structures were made from slides mounted in lactophenol.

Taxonomic Description

***Exserohilum heteromorphum* G. Y. Sun sp. nov.**

Figure 1

Coloniae in TWA + wheat straw effusae, atrobrunneae. Stromata nulla. Conidiophora cylindrica, simplicia vel faciculata, laevia, septata, recta vel flexuosa, usque ad 1000 μ m longa, ad basim tumida 12-16 μ m diam, prope basim 7-10 μ m diam, ad apicem 4-6 μ m diam, Cellulae conidiogenae polytreticae, in conidiophoris incorporatae, terminales plerumque intercalares. Conidia cylindrica, fusiformes, recta vel curvata, interdum abrupte curvata, laevia, concoloria, 5-11 (plerumque 7-8) distoseptata, (90-) 130-185 (-245) $\times$ (15-) 20-31 μ m, basi obconica, truncato hilo protrudenti. Hilum 2-2.5 μ m diam.

Holotypus: ex foliis Echinochloa crusgalli (L.) Beauv. var. mitis (Pursh) Peterm., China, Shaanxi, Yangling, HMUABO (Herbarium Mycologicum Universitatis Agriculturae Boreali- Occidentalis) 20579.

Colonies on TWA + wheat straw effuse, dark brown, sporulating liberally, stromata absent, aerial mycelium absent. Conidiophores cylindrical, simple or fasciculate in small groups, smooth, septate, straight to flexuous, up to 1000 μ m long, 12-16 μ m diam. at the base, 7-10 μ m diam. just above base and 4-6 μ m at apex. Conidiogenous cells integrated, terminal and intercalary, polytretic, sympodial, cicatrized with prominent scars. Conidiogenous nodes smooth, up to 200 μ m apart. Conidia single, fusiform, smooth, straight, curved, sometimes abruptly curved at any cell, even at end cells, occasionally sigmoid, pale brown to brown, concolorous, 5-11 (mostly 7-8) distosepta, (90-) 130-185 (-245) $\times$ (15-) 20-31 μ m, with a protruding hilum 2-2.5 μ m in diameter at the truncate base. On the basis of these observations, the fungus is ascribable to the hyphomycete genus *Exserohilum* Leonard & Suggs.

In *Exserohilum*, abruptly curved conidia are also found in *E. curvatum* Sivan. & Muthaiyan (Sivanesan, 1987) but they are smaller than that in *E. heteromorphum*, and their end cells are often cut off by a thick dark septum. In *E. oryzinum* Sivan. (Sivanesan, 1987), some conidia are sigmoid, but the basal cell of conidia sometimes bulges a little. The species *E. curvisorum* A. Sivanesan, S. K. Abdulah & B. A. Abbas, also has sigmoid conidia, but they are smaller and narrower than that in *E. heteromorphum*, and are mostly strongly curved. Five *Exserohilum* species have been reported on the genus *Echinochloa*, but they can be easily separated from *E. heteromorphum* by the absence of abruptly curved conidia. Since the single isolate of *E. heteromorphum* failed to produce a teleomorph on TWA + wheat straw or Sachs's agar medium containing sterilized wheat straw or rice grain, this fungus is probably a heterothallic species or the conditions were unsuitable for teleomorph production.

Acknowledgments

This work was supported by National Natural Science Foundation of China (NSFC, No. 30170004). The authors wish to thank Dr. J. L. Alcorn (Plant Pathology Herbarium, Department of Primary



Fig. 1 Conidia and conidiophores of *Exserohilum heteromorphum* (bar=50 μ m)

Industries, Indooroopilly, Australia), Dr. Thomas Harrington (Department of Plant Pathology, Iowa State University, Ames, USA) and Professor Tianyu Zhang (College of Plant Protection, Shandong Agricultural University, Taian, China) for reviewing our manuscript, Dr. A. Porta-Puglia (Istituto Sperimentale per la Patologia Vegetale, Rome, Italy) for providing some fungal strains, Dr. J. L. Alcorn and Dr. A. Quacquarelli (Istituto Sperimentale per la Patologia Vegetale, Rome, Italy) for sending references.

Literature Cited

- Alcorn JL. 1988. A new species of *Exserohilum*. Transactions of the British Mycological Society 90: 146-148.
- Alcorn JL. 1991. New combinations and synonymy in *Bipolaris* and *Curvularia*, and a new species of *Exserohilum*. Mycotaxon 41: 329-343.
- Castañeda Ruiz RF, Guarro J, Cano J. 1995. A new species of *Exserohilum* from Cuba. Mycological Research 99(7): 825-826.
- Del Serrone P, Porta-puglia A, Sivanesan A. 1991. A new species of *Exserohilum* on Barnyardgrass. Phytopathologia Mediterranea 30: 151-152.
- Guirand P, Steiman R, Seigle MF, Sage L. 1997. *Exserohilum sodomii*, a new species isolated from soil near the Dead Sea (Israel). Antonie Van Leeuwenhoek 72: 317-325.
- Leonard KJ, Suggs EG. 1974. *Setosphaeria prolata*, the ascigerous state of *Exserohilum prolatum*. Mycologia 66: 281-297.
- Peng JH, Lu JY. 1989. Study on *Bipolaris*, *Drechslera* and *Exserohilum*. Journal of Nanjing Agricultural University 12(4): 46-53.
- Sivanesan A. 1987. Graminicolous species of *Bipolaris*, *Curvularia*, *Drechslera*, *Exserohilum* and their teleomorphs. Mycological Papers 158: 1-261.
- Sivanesan A. 1992. New *Bipolaris*, *Curvularia* and *Exserohilum* species. Mycological Research 96: 485-489.
- Sivanesan A, Abdulah SK, Abbas BA. 1993. *Exserohilum curvisporum* sp. nov., a new hyphomycete from Iraq. Mycological Research 97: 1489-1488.
- Steiman R, Guirand P, Seigle MF, Sage L. 2000. *Exserohilum Israel*, a new species isolated from soil from Timna Park (Israel), and its physiological properties. Antonie Van Leeuwenhoek 78: 86-87.
- Sun GY, Zhang TY. 1996. A simple method of isolating single spores. Plant Quarantine 10: 40-41.
- Sun GY, Zhang R, Zhu MQ, Zhang TY. 1996. A new record species of *Exserohilum* from China. Acta Mycologica Sinica 15(4): 311-312.
- Sun GY, Zhang R, Zhu MQ, Zhang TY. 1997. A new species of *Exserohilum* from China. Mycological Research 101: 776-778.
- Tai FL. 1979. Sylloge fungorum sinicorum. Science Press, Academia Sinica, Peking China.
- Upadhyay HP, Mankau R. 1991. *Dactylaria nervicola* sp. nov. and *Exserohilum novae-zelandiae* comb. nov. from Mexico. Mycologia 83: 371-376.
- Wu WP. 1990. Contribution to the knowledge of Graminicolous "*Helminthosporium*" in Hebei Province (II). Journal of the Hebei Academy of Sciences Selected Papers: 49-64.

New records of ascomycetes from Jalisco, Mexico

MARÍA DEL REFUGIO SÁNCHEZ-JÁCOME & LAURA GUZMÁN-DÁVALOS*

*lguzman@cucba.udg.mx

Departamento de Botánica y Zoología, Universidad de Guadalajara

Apartado postal 1-139, Zapopan, Jal., 45101, Mexico

Abstract — Sixteen ascomycete species belonging to three orders are discussed. *Entonaema moluccanum*, *Helvella cupuliformis*, *Peziza ampliata*, *P. atrovinosa*, *P. praetervisa*, *P. vesiculosa* and the anamorph of *Xylaria cubensis*, *Xylocoremium flabelliforme*, are reported for the first time from Mexico. Furthermore, *Geopyxis vulcanalis*, *Helvella dissingii*, *Hypoxylon lividipigmentum*, *H. nitens*, *Iodowynnea auriformis*, *Lachnum abnorme*, *Sowerbyella rhenana* and *Xylaria* cf. *laevis* are new reports for the state of Jalisco. New localities for *X. quercinophila* in Jalisco are also cited.

Key words — *Helotiales*, *Pezizales*, *Xylariales*

Introduction

The study of macrofungi from the state of Jalisco, Mexico has focused mainly on the basidiomycetes. According to García-Romero et al. (1970), Chacón and Guzmán (1983a), Guzmán-Dávalos and Fragosa (1996), Ju et al. (1997), San Martín and Lavín (1997), Medel et al. (1999), Rubio-Bustos et al. (2000) and San Martín et al. (1999, 2001), only 87 non-lichenized species of ascomycetes were known from Jalisco. We recently added 16 new records in Guzmán-Dávalos et al. (2003) for a total of 103 species. The majority of these species are mentioned in fungistic lists; few are treated in papers exclusively about ascomycetes, such as Pérez-Silva (1973, 1975, 1977, 1978, 1983), Blackwell and Gilbertson (1981, 1984), Chacón and Guzmán (1983b), Pérez-Silva et al. (1983), Medel et al. (1989), Guzmán-Dávalos and Rodríguez (1995) and those already cited above from 1997 to 2003.

Jalisco is one of the 32 states of Mexico and is located in central western part of the country. There are 13 different major types of vegetation, from tropical deciduous forests to alpine vegetation, including an important representation of Mexican pine and oak forests (Rzedowski and McVaugh, 1966).

Our study was prompted by the relatively few papers regarding ascomycetes in Jalisco and the small number of ascomycete collections in the IBUG Mycological Herbarium. This paper contributes new knowledge on this important class of fungi in Mexico.

Material and Methods

All the material studied is from the state of Jalisco and is deposited in the Mycological Herbarium IBUG, except when indicated. For the microscopic observations 3% KOH, Cotton Blue in lactophenol and Melzer's Reagent were employed. Breitenbach and Kränzlin (1984), Chacón and Guzmán (1985), Dennis (1970, 1981), Dissing et al. (2000), Rogers (1981, 1984, 1986), San Martín and Rogers (1989), San Martín et al. (1999) and Spooner (2001) were consulted to aid in species identification. Brief annotations are provided for species reported for the first time from Jalisco. New records for the country are completely described. Color reference numbers in parentheses are from Kornerup and Wanscher (1989).

Results

Sixteen species representing three orders of ascomycetes are treated: *Pezizales* (9), *Helotiales* (1) and *Xylariales* (6). Of these, seven are new records for Mexico and eight from Jalisco State. New localities for *Xylaria quercinophila*, a species recently cited from Mexico, are mentioned.

ORDER PEZIZALES

Family *Helvellaceae*

Helvella cupuliformis Dissing & Nannf., Svensk Bot. Tidskr. 60: 326, 1966.

Figs. 1–3

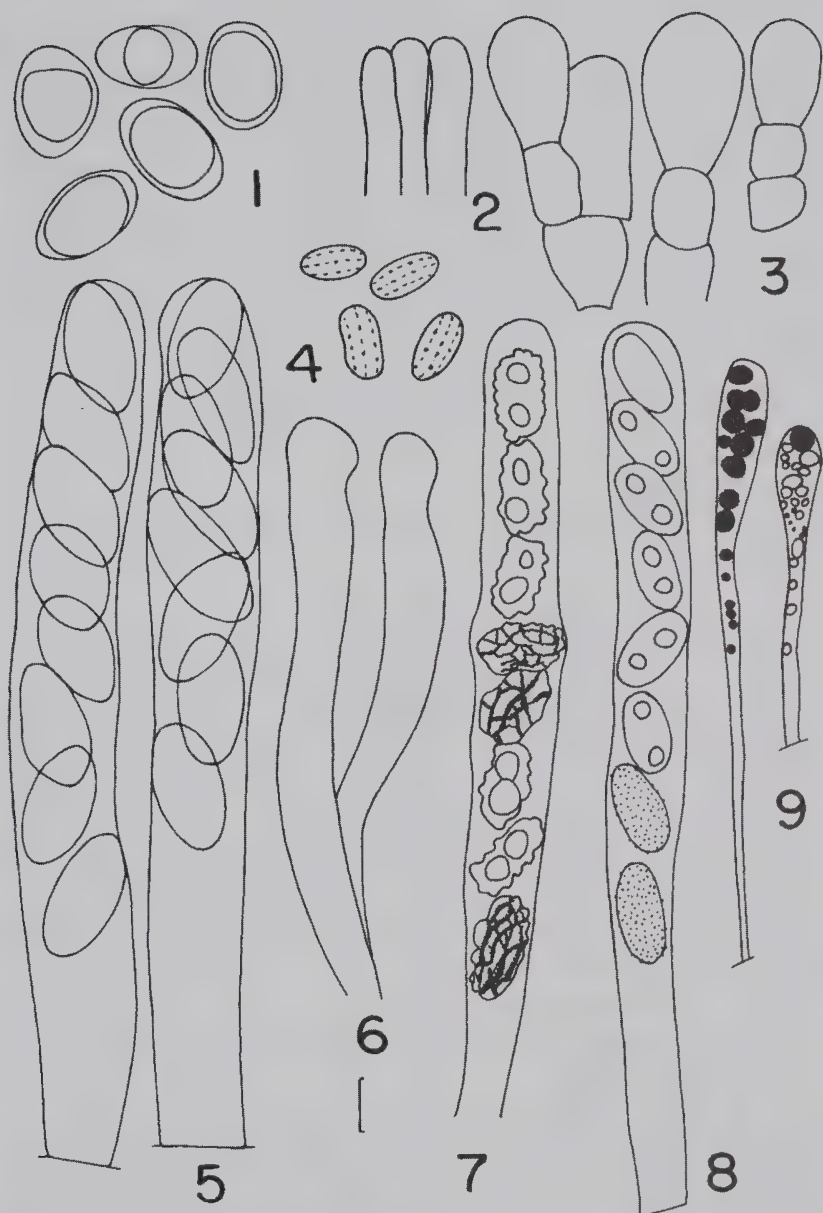
Apothecia gregarious, 9–15 mm diam. in dry condition, shallow or deeply cupulate, edge irregularly incurved, margin smooth, even; hymenium smooth, yellowish-gray or grayish-brown (6E3). Receptacle strongly furfuraceous, yellowish (4A4, 4A3), becoming yellowish-gray (4B3). Stipe ca. 5–10 x 1.5–3 mm in dry condition, cylindrical to complanate, uniform, solid, surface furfuraceous, concolorous with the receptacle; base with whitish mycelia.

Ascospores 17–20 x 11–14 μm , widely ellipsoid to ellipsoid, smooth, hyaline with a big refractive guttule. Asci 220–275 x 15–20 μm , cylindrical, octosporous, uniseriate, hyaline. Paraphyses of the same length as the asci and 4.5–8 μm wide, cylindrical, with rounded apices. Ectal excipulum of texture globular to angularis, yellowish-brown.

Habitat – On soil in disturbed tropical deciduous forest.

Specimen examined – Municipality of Autlán, 3 km N of Autlán, Ayotita, October 1, 1988, *Zamarripa* 134.

Observations – This is the first record of this species in Mexico. The studied material agrees in part with the description of Breitenbach and Kränzlin (1984, as *Cyathipodia cupuliformis*). The Mexican material has smaller asci and is from a different habitat. Breitenbach and Kränzlin (1984) reported asci of 300–350 x 17–20 μm and from coniferous forest. It is related to *H. dissingii* Korf [= *H. villosa* (Hedw.) Dissing & Nannf.] differing by having smaller spores and different ascoma color (Breitenbach and Kränzlin, 1984).



Figs. 1–9. 1–3: *Helvella cupuliformis*, 1: ascospores, 2: paraphyses apex, 3: elements of ectal excipulum. 4: *Iodowynnea auriformis*, ascospores. 5–6: *Peziza ampliata*, 5: asci with ascospores, 6: paraphyses. 7: *Peziza atrovinosa*, ascus with ascospores. 8–9: *Peziza pratervisa*, 8: ascus with ascospores, 9: paraphyses.

Helvella dissingii Korf, Mycotaxon 31: 381, 1988.

Fig. 20

It is characterized by apothecia ca. 6–10 mm diam. when dry, gregarious, plane, margin even, hymenium smooth, grayish-brown (10F3), receptacle furfuraceous, grayish-orange (5C4) and a white stipe. The ascospores are $17.5\text{--}22.5 \times 9.5\text{--}13.5 \mu\text{m}$, ellipsoid, smooth, with a refractive guttule, hyaline. The asci are cylindrical, octosporous, uniseriate, hyaline, and the paraphyses are claviform in the apices. It is related to *H. macropus* (Pers. : Fr.) P. Karst. which has larger ascoma and ascospores. This species was cited before as *Helvella villosa* (Hedw. ex Kunth) Dissing & Nannf. by Pompa-González and Cifuentes (1991) from Guerrero State; the valid name is *H. dissingii* according to Dougoud (2000). This is the second record for Mexico.

Habitat – On soil in transition zone between pine-oak and mesophytic forests.

Specimen examined – Municipality of Tecalitlán, Sierra del Halo, km 16 road Tecalitlán-Jilotlán, alt. 1850 m, August 28, 1988, *Guzmán-Dávalos 4388*.

Family *Pezizaceae*

Iodowynnea auriformis (Pat. ex Le Gal) Medel, Guzmán & S. Chacón, Mycotaxon 59: 128, 1996.

Fig. 4

It is characterized by gregarious apothecia, ca. 40 mm diam. in dry condition, irregular cups, with irregular wavy margins, edge furfuraceous, incurved or torn in parts, hymenium smooth, violet-brown (11F4), receptacle strongly furfuraceous, concolored with the hymenium. This species normally presents a stipe, absent in the studied material because it was not correctly collected. The ascospores are a distinctive character; they are $10.5\text{--}12.5 \times 4.5\text{--}6.5 \mu\text{m}$, ellipsoid, with the apices subtruncate, with longitudinal warty stripes, with one to three refractive guttules, hyaline. The asci are cylindrical, octosporous, uniseriate, hyaline and amyloid in the apices. The paraphyses are septate, with rounded apices. This species was known from mesophytic forest; however, the studied material was collected in an urban area. This is the second record for Mexico, having earlier been reported by Medel et al. (1996) with specimens from the state of Veracruz. This species is also known from Venezuela and Trinidad as *Galactinia auriformis* Pat. ex Le Gal (Dennis, 1970).

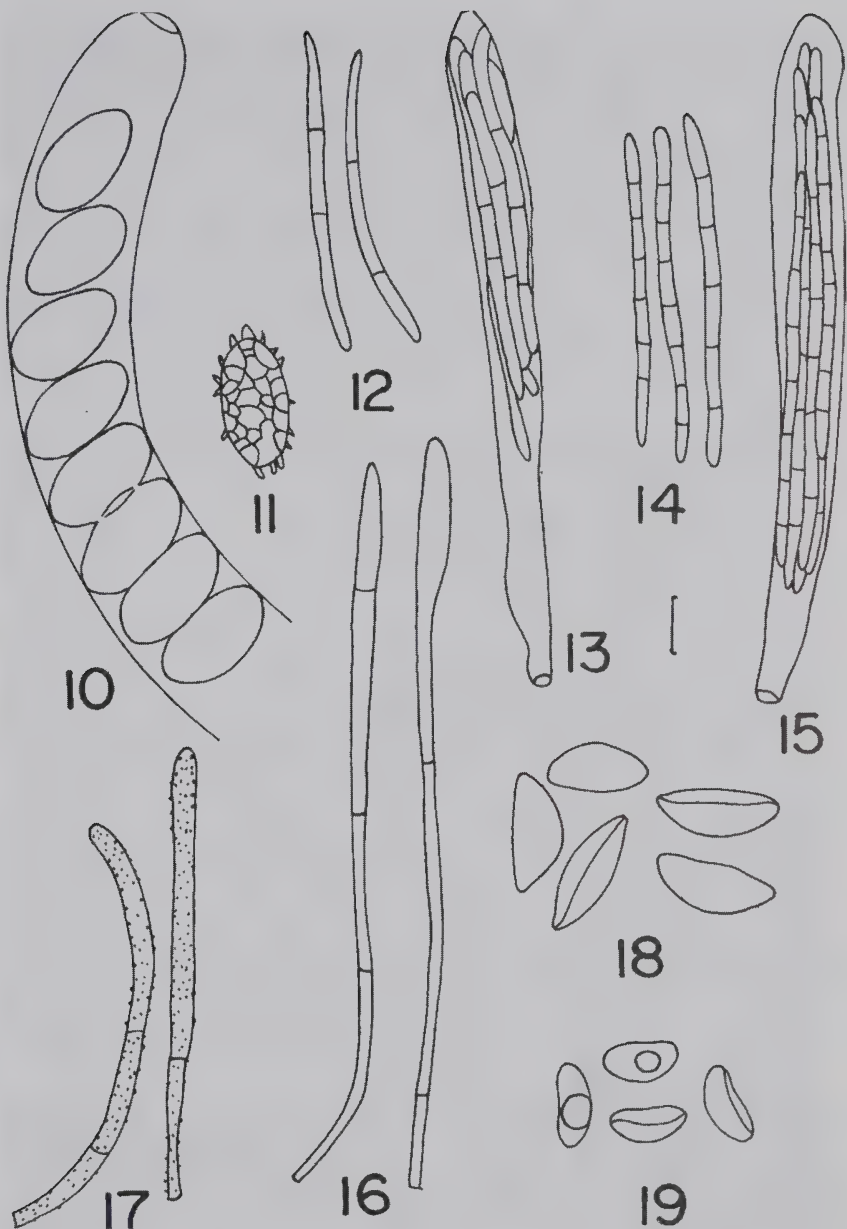
Habitat – On soil in a subtropical urban site.

Specimen examined – Municipality of Guadalajara, Guadalajara, alt. 1500 m, August 1, 1989, *Reynoso s.n.*

Peziza ampliata Pers., in Pant, Mycologia europaea (Erlanga) 1: 227, 1822.

Figs. 5–6

Apothecia gregarious, 8–24 mm diam., cupuliform, more shallow when mature and with a small central depression, with the edge decurved, margin smooth, even to slightly torn; hymenium smooth, brown with reddish-orange tinges (8F7) and margin darker. Receptacle smooth, darker than the hymenium. Sessile, base wide, with yellowish (4A6) mycelium.



Figs. 10–19. 10: *Peziza vesiculosa* (Vázquez 898), ascus with ascospores. 11: *Sowerbyella rhenana*, ascospore. 12–17: *Lachnum abnormis*, 12: ascospores, 13: ascus (Guzmán-Dávalos 5832), 14: ascospores, 15: ascus, 16: paraphyses, 17: excipulum hairs (Vázquez 839). 18: *Entonaema moluccanum*, ascospores. 19: *Xylaria* cf. *laevis*, ascospores (Guzmán-Dávalos 5960).

Ascospores $19\text{--}22.5 \times 10.5\text{--}12.5 \mu\text{m}$, ellipsoid, smooth, hyaline, slightly dextrinoid. Asci $197\text{--}323 \times 13.5\text{--}17.5 \mu\text{m}$, cylindrical, octosporous, uni- or biseriate, amyloid in the spore region. Paraphyses of the same length as the asci and $9.5 \mu\text{m}$ wide, cylindrical, with apices slightly capitate, hyaline, amyloid. Ectal excipulum of texture globular, easily collapsed, yellowish.

Habitat – On soil with wood debris, in mesophytic forest.

Specimen examined – Municipality of Autlán, Sierra de Manantlán, Manantlán Biosphere Reserve, Predio Las Joyas, road to Piedra Bola, alt. 1900–2100 m, August 30, 1995, *Rodríguez 1274*.

Observations – The studied material agrees with the description of Dennis (1981), but differs in not presenting the ascoma with a denticulate margin. This species is distinguished for being lignicolous and having big spores. This is the first record for Mexico.

Peziza atrovinosa Cooke & W.R. Gerard, Bull. Buffalo Soc. Nat. Sci. 2: 288, 1875.

Fig. 7

Apothecia gregarious, ca. 25–30 mm diam. when dry, cupuliform, edge irregular, incurved, margin slightly furfuraceous, even; hymenium smooth, violet-brown (10F8), or dark reddish-brown (9F8). Receptacle with folds, reddish-brown (7F8). Sessile, with a central or eccentric base.

Ascospores $13.5\text{--}15 \times 7\text{--}9.5 \mu\text{m}$, ellipsoid, with reticulate-warted wall, warts interwoven to form a partial to complete reticulum, with a guttule of bright violaceous content or two of refractive content. Asci $236.5\text{--}275.5 \times 11\text{--}16 \mu\text{m}$, cylindrical, octosporous, uniseriate, hyaline, amyloid at the apex. Paraphyses of the same length or larger than the asci and $4\text{--}4.5 \mu\text{m}$ wide, cylindrical, septate, hyaline with rounded amyloid apex. Ectal excipulum of texture globular, yellowish-brown.

Habitat – On soil in pine-oak forest.

Specimen examined – Municipality of San Sebastián del Oeste, road to Real Alto, 6 km from San Sebastián del Oeste, Portezuelo de Santa Ana, alt. 1900 m, September 14, 1995, *Guzmán-Dávalos 5946*.

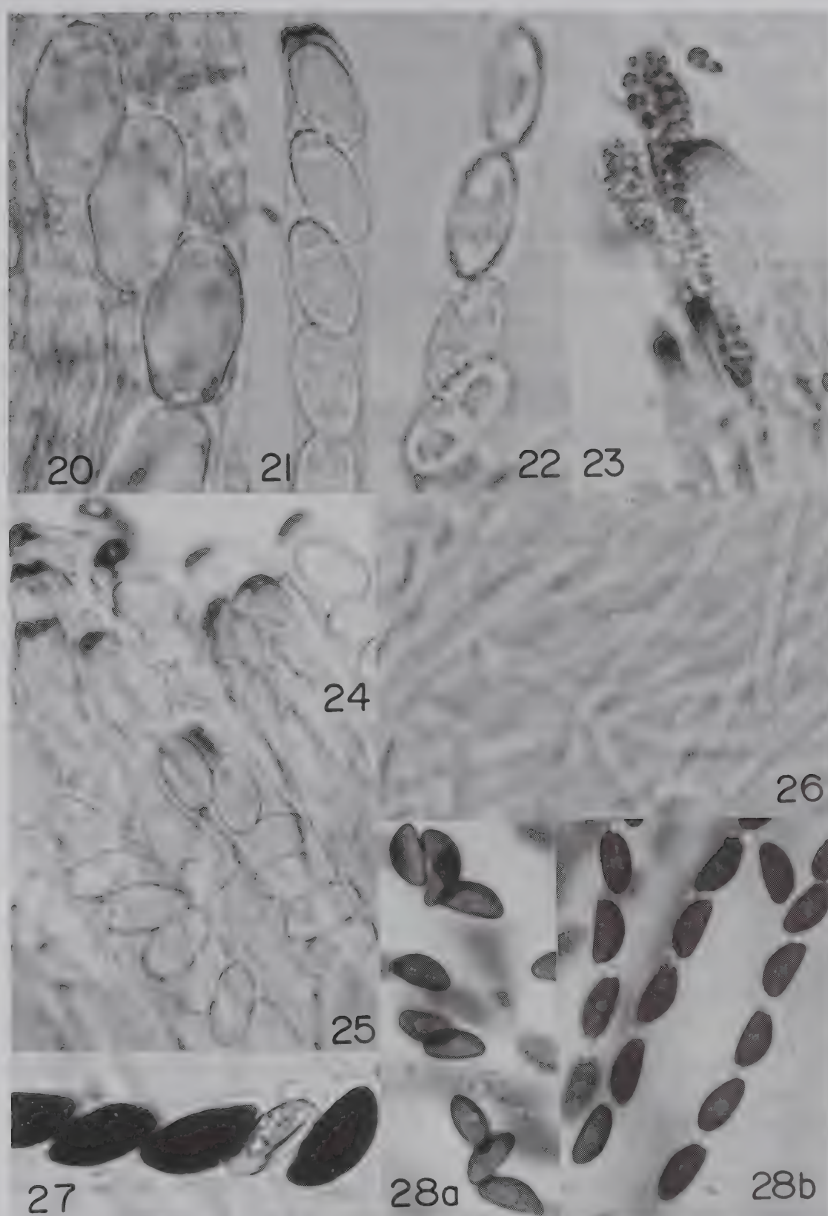
Observations – *Peziza atrovinosa* is distinguished by the apothecia color and ascospores with a marked warty ornamentation. It has been confused with *P. ostracoderma* Korf, which has a smaller apothecia of a different color and which grows on mushroom beds, steam-sterilized soil, or burnt soil (Dennis 1981), while the studied material was found on clay soil.

Peziza praetervisa Bres., Malpighia 11: 266, 1897.

Figs. 8–9, 21–23

Apothecium solitary, ca. 20 mm diam. in dry condition, cupuliform, with waving edge, margin smooth, even; hymenium smooth, dark brown (7F2) to dark violet-brown (10F5). Receptacle pruinose, whitish (4A3) to light brown (5B4). Sessile, with a central attachment point.

Ascospores $12.5\text{--}16 \times 6.5\text{--}8 \mu\text{m}$, ellipsoid, wall slightly warted, with two refractive guttules, hyaline. Asci $197\text{--}276 \times 9\text{--}12.5 \mu\text{m}$, cylindrical, octosporous, uniseriate,



Figs. 20–28. 20: *Helvella dissingii*, ascospores. 21–23: *Peziza pratensis*, 21: amyloid ascus apex, 22: ascospores, 23: paraphyses. 24–25: *Peziza vesiculosa* (Vázquez 898), 24: amyloid ascus apex, 25: ascospores. 26: *Geopyxis vulcanalis*, bifurcate ascus base. 27: *Hypoxylon lividipigmentum* (Núñez 17), ascospores with hyaline perisporium. 28a–b: *Hypoxylon nitens*, ascospores.

hyaline, apex amyloid, more intense in the apical operculum. Paraphyses of the same length as the asci, 2.5–4 μm wide, apex 4.5–9.5 μm , claviform, slightly bent, with multiple reddish-brown guttules. Ectal excipulum of texture globular, yellowish.

Habitat – On soil in pine-oak forest.

Specimen examined – Municipality of Zapotlán El Grande, Nevado de Colima, km 17 road El Fresno-Antena del Canal 13, alt. 2750 m, September 12, 1986, *Guzmán-Dávalos 3570*.

Observations – The studied material agrees with the descriptions of Dennis (1981) and Breitenbach and Kränzlin (1984), except that Dennis mentioned that the apex of the paraphyses as being more bent and with purple granulations.

Peziza vesiculosa Bull. : Fr., *Herbier de la France* 10: tab. 457, fig. 1, 1790.

Figs. 10, 24–25

Apothecia 15–25 mm diam., cupuliform, easily breakable, with incurved edge, margin smooth, even; hymenium smooth, translucent, dark brown (7F8) to yellowish-brown (5C8). Receptacle warted, orange-brown (5C4, 5C3). Sessile, with a central attachment point.

Ascospores 22.5–265.5 x 12–14.5 μm , ellipsoid, smooth, hyaline. Asci 220–315 x 20–30 μm , cylindrical, octosporous, uniseriate, operculate, hyaline, apex amyloid, very intense in the operculum. Paraphyses of the same length as the asci, 3–6 μm wide, cylindrical, septate, with rounded apex, hyaline. Ectal excipulum formed by pyriform elements, easily collapsed, yellowish.

Habit and habitat – Solitary or gregarious, on humus in tropical deciduous forest.

Specimen examined – Municipality of Guadalajara, Barranca de Huentitán, alt. 1340–1590 m, September 17, 1986, *Vázquez 272*; alt. 1250–1500 m, August 29, 1989, *Vázquez 898*.

Observations – The studied material agrees with Dennis (1981), Breitenbach and Kränzlin (1984), Dissing et al. (2000) and Spooner (2001). Dissing et al. (2000) recorded the spores 20–23 x 9–12 μm , slightly smaller than the Mexican materials. *Peziza vesiculosa* is cited for the first time from Mexico.

Family Pyronemataceae

Geopyxis vulcanalis (Peck) Sacc., Syll. Fung. 8: 65, 1889.

Figs. 26, 29

It is characterized by gregarious apothecia, ca. 1–4 mm diam. in dry condition, deeply cupulate, margin denticulate, light orange (5A5), hymenium smooth, orange (6A8, 5A8) and the receptacle orange-brown (7C4, 7C5). The ascospores are 13.5–19 x 6.5–9.5 μm , ellipsoid, with slight encrustations giving them a granular appearance, grayish-olivaceous. The asci are cylindrical, octosporous, uniseriate, not operculate, with a bifurcate base, hyaline. The paraphyses are cylindrical, septate, hyaline. This is the second record for the country, it was cited for the State of Mexico by Chacón and Guzmán (1985). The material from Jalisco agrees with Chacón and Guzmán (1985) description, but differs in the presence of encrustations on the spores and in the bifurcate base of the asci, both characters not mentioned by them.

Habitat – Among mosses in an *Abies durangensis*, *Pinus*, and *Quercus* forest.

Specimen examined – Municipality of Mezquitic, between Huejuquilla el Alto and Los Amoles, alt. 1870 m, July 31, 1996, *Rodríguez 1451*.

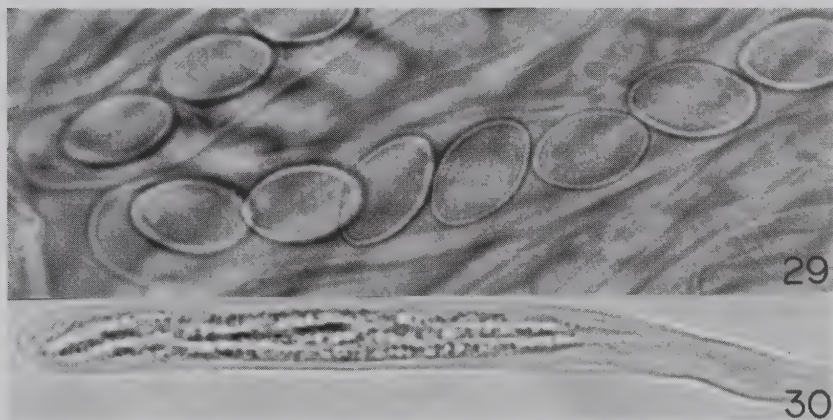
Sowerbyella rhenana (Fuckel) J. Moravec, *Mycologia Helvetica* 2: 96, 1986.

Fig. 11

It is characterized by gregarious apothecia, 5–15 mm diam., margin furfuraceous, even, hymenium tomato-red (8C8) to reddish-brown (8F8), the receptacle pulverulent, whitish-orange (5C6, 6D7), and the stipe 11–20 mm long, cream color (4A3). The ascospores are $18\text{--}28.5 \times 8\text{--}9.5 \mu\text{m}$, ellipsoid, with warts forming a net, being the warts bigger in the apex, with two refractives guttules. The asci are cylindrical, octosporous, uniseriate, and the paraphyses are larger and bent toward the asci. This species has been cited from the States of Guerrero, Hidalgo, Mexico, Michoacán, Querétaro, Veracruz and the valley of Mexico (Guzmán, 1977; Mapes et al., 1981; Zarco, 1981; Frutis and Guzmán, 1983; Guzmán and Villarreal, 1984; Pompa-González and Cifuentes, 1991; García et al., 1998). Although it is widely distributed in the country, this is the first time that it is recorded from Jalisco.

Habitat – On wood in mesophytic forest.

Specimen examined – Municipality of Zapotlán el Grande, Nevado de Colima, El Floripondio, alt. 2950 m, July 27, 1995, *Álvarez 1115*.



Figs. 29–30. 29: *Geopyxis vulcanalis*, ascus with ascospores. 30: *Lachnum* cf. *abnorme* (Núñez Cárdenas 37), ascus with ascospores.

ORDER HELOTIALES

Family Hyaloscyphaceae

Lachnum abnorme (Mont.) J.H. Haines & Dumont, *Mycotaxon* 19: 10, 1984.

Figs. 12–17

It is characterized by the small gregarious apothecia, 1–2 mm diam., cupuliform, more or less plane, with a villose, whitish margin, hymenium orange-yellow (5A3), the receptacle with pale buff hairs, and a very small to long, robust and pale to dark brown

stipe. The ascospores are $33.5\text{--}52 \times 1.5\text{--}2.5 \mu\text{m}$, filiform, 0–7 septate, with refractive granulations, hyaline. The asci are cylindrical, octosporous, hyaline, slightly amyloid in the apical pore, and the paraphyses are lanceolate, septate. The ectal excipulum has cylindrical, septate, slightly encrusted, hyaline to yellowish hairs. *Lachnum abnorme* was previously cited by Welden and Lemke (1961) and Haines and Dumont (1984) from Veracruz, and Chacón and Guzmán (1983b) from the State of Mexico.

Habitat – On branches and trunks in tropical deciduous forest, in a disturbed tropical deciduous forest or in a garden in a subtropical zone.

Specimens examined – Municipality of Chapala, road to Acoco dam, alt. 1600 m, August 30, 1984, *Trujillo 670*; Municipality of Guadalajara, Avenida Bulevar Tlaquepaque, July 9, 1993, *Guerrero 31*; Barranca de Huentitán, August 15, 1989, *Vázquez 839*; Municipality of Zapopan, Avenida Naciones Unidas, Villas Nueva Galicia, Northern cliff, June 19, 1994, *Guzmán-Dávalos 5832*.

Lachnum cf. abnorme

Fig. 30

Apothecia gregarious, 0.5–2 mm diam., cupuliform, with the margin villose, hymenium orange (5A5), receptacle villose, with pale brown or more common pinkish-brown hairs, and with a dark brown, leathery, short stipe. The ascospores are $33.5\text{--}57 \times 1.5\text{--}3 \mu\text{m}$, filiform, with abundant refractive granules, 0–1(–3) septate, hyaline. The asci are cylindrical, octosporous, hyaline, with the apical pore slightly amyloid and the paraphyses are lanceolate, projecting beyond the asci. The ectal excipulum has hairs with yellowish-brown encrustations. The materials are distinguished from *L. abnorme* by longer and darker hairs of the receptacle and ascospores with fewer septa.

Habitat – On branches and trunks, in mesophytic forest or in gardens in subtropical zone.

Specimens examined – Municipality of Zapotlán El Grande, Nevado de Colima slopes, El Floripondio, alt. 2300 m, July 12, 1998, *López 17*; Municipality of Guadalajara, University of Guadalajara, Facultad de Ciencias Biológicas, Avenida Bulevar Tlaquepaque, June 29, 1993, *Espinoza 14*; June 30, 1993, *Núñez Cárdenas 37*; Municipality of Zapopan, Nextipac, University of Guadalajara, Centro Universitario de Ciencias Biológicas y Agropecuarias, July 6, 1999, *López Damián 38*.

ORDER XYLARIALES

Family Xylariaceae

Entonaema moluccanum J.D. Rogers, [as '*moluccana*'], Mycologia 73: 56, 1981.

Fig. 18

Stroma solitary or gregarious, ca. 30 x 25 mm diam., globose, surface powdery, with multiple folds, lemon-yellow (3A8), dark-yellow (4A8), with reddish-orange tinges (8A8). Inside with slimy material, greenish-yellow when fresh, turning pinkish-brown (6E8) or dark brown (6F8) when dry; the gelatinous material stains the outer surface with olivaceous shades.

Ascospores $15\text{--}18.5 \times 6\text{--}7 \mu\text{m}$, ellipsoid, inequilateral, apices acute, germ line longitudinal not covering all the length, brown, with hyaline perisporium.

Habitat – On wood in tropical subdeciduous forest.

Specimens examined – Municipality of San Sebastián del Oeste, Arroyo el Viborón, August 15, 1998, *Guzmán-Dávalos* 7359; Javier Curiel's orchard, August 14, 1998, *Guzmán-Dávalos* 7285.

Observations – The studied material agrees with the description of Rogers (1981). The species is related to *E. liquescens* A. Møller that was cited for Jalisco by San Martín and Lavín (1997); it differs in the form and size of the spores. Furthermore, Rogers (1981) mentioned that *E. moluccanum* has folds in the surface, while *E. liquescens* does not. However, when we compared herbarium material of the two species, the wrinkles were observed in both. For this reason the determination was based only on the characters of the spores.

Hypoxylon lividipigmentum F. San Martín, Y.M. Ju & J.D. Rogers, Mycol. Mem. 20: 145, 1996.

Fig. 27

It is characterized by the plane, resupinate gregarious stromata, 1 mm thick, with inconspicuous or poorly evident perithecia, violet-brown (11F5, 12F8), with black dots and a dark vinaceous pigment released in KOH. The ascospores are 11–14 x 5.5–6.5 μm , ellipsoid, apices rounded, with a longitudinal germ line, dark brown, with a hyaline perisporium, dehiscent in KOH. The material from Jalisco coincides with the description made by San Martín et al. (1999). This species has been recorded from Oaxaca and Quintana Roo.

Habitat – On wood in oak forest and tropical deciduous forest.

Specimens examined – Municipality of Arandas, km 1.5 road Arandas-León, September 22, 1991, *Núñez* 17; Municipality of Guadalajara, Barranca de Huentitán, alt. 1500 m, September 19, 1989, *Vázquez* 920.

Hypoxylon nitens (Ces.) Y.-M. Ju et J. D. Rogers, Mycol. Mem. 20: 220, 1996.

Fig. 28

It is distinguished by an effuse-pulvinate gregarious stroma which merges with others to form big masses, black, with superficial perithecia, spherical to ovoid, with a papillate ostioles, surrounded by a disc. An olivaceous to black pigment is released in KOH. The ascospores are 7–9.5 x 3–4 μm , ellipsoid, equilateral, apices rounded, some acute, germ slit in the convex side, not very evident, olivaceous-brown. This species was previously reported from Chiapas and Tamaulipas by San Martín et al. (1999).

Habitat – On wood in mesophytic forest.

Specimen examined – Municipality of Autlán, Reserva de la Biosfera Sierra de Manantlán, Predio Las Joyas, road from Zarzamora to Puerto de San Campus, alt. 1900–2100 m, October 15, 1985, *Guzmán-Dávalos* 2965 (IBUG, XAL).

Xylaria cf. *laevis* Lloyd, Notes I, Mycol. Writ. 5: 8, 1918.

Fig. 19

Our specimens have gregarious to caespitose claviform stroma, with smooth, fertile and rounded apices, the ostioles are evident and the surface is vinaceous-brown. The stipe

is 10–25 x 7 mm, with a velutinous base, black. The ascospores are 9.5–12 x 4–5 μm , ellipsoid, olivaceous, with rounded apices and longitudinal germ slit. The asci present an amyloid rectangular apical ring in Melzer's reagent. The studied material agrees with the specimen from Tamaulipas studied by San Martín and Rogers (1989), and identified by them as *Xylaria* cf. *laevis*. On the other hand, *Xylaria laevis* was recorded from Chiapas and Quintana Roo by San Martín and Rogers (1995).

Habitat – On wood in pine-oak forest.

Specimens examined – Municipality of San Sebastián del Oeste, 6 km from San Sebastián to Real Alto, Portezuelo de Santa Ana, alt. 1900 m, September 14, 1995, *Guzmán-Dávalos 5960*; Municipality of Tequila, Cerro de Tequila, Summers of 1975–1976, *Manzi s.n.*

Xylaria quercinophila F. San Martín, J.D. Rogers & P. Lavín, Mycotaxon 79: 349, 2001.

It is characterized by presenting conic gregarious stroma, with a whitish rounded fertile apex, distinct black ostioles, with a short or long, pannose, dark brown stipe that has a corky consistency. The ascospores are 19–23 x 8–9.5 μm , ellipsoid, inequilateral, brown, rounded apices, with a sigmoidal germ slit. The asci have an amyloid quadrangular apical ring in Melzer's reagent. This species was cited as *Xylaria* aff. *enterogena* by San Martín and Rogers (1989) from Nuevo León and Tamaulipas and by García et al. (1998) from Querétaro. San Martín et al. (2001) described it as a new species and reported for the first time from Jalisco and Veracruz. In Jalisco is very frequent in the area of the Manantlán Biosphere Reserve; in this paper we recorded it from new localities outside the reserve.

Habitat – On wood in pine, oak, pine-oak and mesophytic forests and secondary vegetation.

Specimens examined – Municipality of Mazamitla, Mazamitla surroundings, September 24, 1999, *Guzmán-Dávalos 8091*; Municipality of Atenguillo, Cerro de la Campana, alt. 2850–2860 m, July 1993, *Rodríguez 875 b*; Municipality of Autlán, Sierra de Manantlán, Manantlán Biosphere Reserve, Predio Las Joyas, Sendero Xilosuchitlán, August 10, 1996, *Rubio 389*; El Zarzamoro, alt. 1890, August 1985, *Téllez 231*; Los Barbechos, alt. 1865 m, August 1985, *Téllez 289*; road to Piedra Bola, alt. 1900–2015 m, August 30, 1995, *Oliva 185*; Municipality of Cuautitlán, Sierra de Manantlán, Manantlán Biosphere Reserve, Cuatro Caminos, alt. 2000 m, September 28, 1995, *Rubio 297*; Meseta de San Miguel, alt. 2300 m, September 3, 1982, *Nieves & Vazquez 75*; Municipality of Tolimán, Manantlán Biosphere Reserve, km 9–10 road to El Terrero, alt. 1800 m, August 2, 1990, *Salcedo Pérez s.n.*

Xylocoremium flabelliforme (Schwein. : Fr.) J. D. Rogers, Mycologia 76: 914, 1984.

Anamorph of *Xylaria cubensis* (Mont.) Fr.

Anamorph stromata gregarious, ca. 5–20 x 5–10 mm in dry condition, fertile portion foliar to cerebriform, pulverulent, whitish (5A2), yellowish (5A5) to pinkish-orange (6A4), with a short, cylindrical, pannose, dark brown (6F4) stipe. Conidia 3–7 x 1.5–2.5 μm , cylindrical, with a truncate side.

Habitat – On wood in mangrove, tropical deciduous forest and mesophytic forest.

Specimens examined – Municipality of San Sebastián del Oeste, E of San Sebastián del Oeste, road to Los Reyes, June 26, 1998, *Herrera 116*; road San Sebastián del Oeste-La Bufa, Segundo Arroyo, alt. 1320 m, June 27, 1998, *Herrera 167*; Municipality of Pihuamo, state limit between Colima and Jalisco, road Colima-Jiquilpan, Crucero del Naranjo, July 18, 1998, *Guzmán-Dávalos 7164*; Municipality of La Huerta, Laguna El Tecuán, July 3, 1999, *Rodríguez 2087*.

Observations – The material from Jalisco agrees in the form of the anamorph as well as in the size of the conidia described by Rogers (1984). He described the size of the conidia from culture, and we measured them from field material; however, the size is the same. This is the first record for Mexico.

Acknowledgments

This paper was supported by CONABIO, project FB730/U013, Idea Wild, PROMEP/103.5/03/2580 and University of Guadalajara. María del Refugio Vázquez is thanked for her help inking the drawings. Miguel De Santiago helped in assembling and labeling the photographs. Dr. Dick Korf kindly helped with the determination of one species. Dr. Sharon Cantrell, Dr. Santiago Chacón and Dr. Teuvo Ahti are gratefully thanked for serving as pre-submission reviewers. Dr. Lorelei L. Norvell and Mollie Harker are acknowledged for improving the English text.

Literature Cited

- Blackwell M, Gilbertson RL. 1981. *Cordycepioideus octosporus*, a termite suspected pathogen from Jalisco, Mexico. *Mycologia* 73: 358-362.
- Blackwell M, Gilbertson RL. 1984. New information on *Cordycepioideus bisporus* and *Cordycepioideus octosporus*. *Mycologia* 76: 763-765.
- Breitenbach J, Kränzlin F. 1984. Fungi of Switzerland, Vol. 1. Ascomycetes. *Mykologia*, Luzern.
- Chacón S, Guzmán G. 1983a. Especies de macromicetos citados de México, V. Ascomycetes, parte II. *Bol. Soc. Mex. Mic.* 18: 103-114.
- Chacón S, Guzmán G. 1983b. Ascomycetos poco conocidos de México. *Bol. Soc. Mex. Mic.* 18: 183-218.
- Chacón S, Guzmán G. 1985. Ascomycetes poco conocidos en México, II. Discomycetes. *Rev. Soc. Mex. Mic.* 21: 331-344.
- Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. *Kew Bull. Add. Ser.* III. J. Cramer, Lehre.
- Dennis RWG. 1981. British Ascomycetes. Cramer, Vaduz.
- Dissing H, Eckblad F-E, Lange M. 2000. *Pezizales*. In: Hansen L, Knudsen H (eds.). *Nordic Macromycetes*, Vol. 1. Ascomycetes. Nordsvamp, Copenhagen.
- Dougoud R. 2000. Révision de la taxonomie, corrections et remarques sur les Discomycètes contenus dans Champignons de Suisse de Breitenbach & Kränzlin. Tome I, Les Ascomycètes (1981) 1ere édition. *Doc. Mycol.* 30 (117-118): 99-113.
- Frutis I, Guzmán G. 1983. Contribución al conocimiento de los hongos del estado de Hidalgo. *Bol. Soc. Mex. Mic.* 18: 219-265.
- García J, Pedraza-Kamino D, Silva-Barrón CI, Andrade-Melchor RL, Castillo-Tovar J. 1998. Hongos del estado de Querétaro. Universidad Autónoma de Querétaro, Santiago de Querétaro.

- García-Romero L, Guzmán G, Herrera T. 1970. Especies de macromicetos citados de México, I. Ascomycetes, *Tremellales* y *Aphylllophorales*. Bol. Soc. Mex. Mic. 4: 54-76.
- Guzmán G. 1977. Identificación de los hongos. Limusa, Mexico, D.F.
- Guzmán G, Villarreal L. 1984. Estudio sobre los hongos, líquenes y mixomicetos del Cofre de Perote, Veracruz, I. Introducción a la micoflora de la región. Bol. Soc. Mex. Mic. 19: 107-124.
- Guzmán-Dávalos L, Fragos G. 1994 [1996]. Los hongos registrados del estado de Jalisco. Bol. Inst. Bot. (Universidad de Guadalajara) 2(3-4): 109-160.
- Guzmán-Dávalos L, Rodríguez O. 1993 [1995]. Registro de *Morchella guatemalensis* (Fungi, Ascomycotina) para México. Bol. Inst. Bot. (Universidad de Guadalajara) 1(7): 471-475.
- Guzmán-Dávalos L, Rodríguez O, Sánchez-Jácome MR, Chacón S. 2001 [2003]. Ascomycotina conocidos de Jalisco. Bol. Inst. Bot. (Universidad de Guadalajara) 9(1-2): 11-23.
- Haines JH, Dumont KP. 1984. Studies in the *Hyaloscyphaceae* III: The long-spored, lignicolous species of *Lachnum*. Mycotaxon 19: 1-39.
- Ju Y-M, Rogers JD, San Martín F. 1997. A revision of the genus *Daldinia*. Mycotaxon 61: 242-293.
- Kornerup A, Wanscher JH. 1989. Methuen handbook of colour. Methuen, London.
- Mapes C, Guzmán G, Caballero J. 1981. Etnomicología Purépecha. El conocimiento y uso de los hongos en la cuenca de Pátzcuaro. Dir. Gral. Cult. Pop., serie Etnociencia, cuaderno de Etnomicología 2. Soc. Mex. Mic. & Inst. Biol. UNAM, Mexico, D.F.
- Medel R, Chacón S, Guzmán G. 1989. Especies conocidas y nuevos registros de *Hypoxyylon* (*Sphaeriales*, *Xylariaceae*) en México. Rev. Mex. Mic. 5: 149-168.
- Medel R, Guzmán G, Chacón S, Korf RP. 1996. *Iodowynnea*, a new genus of the *Pezizales* known from Africa and tropical America. Mycotaxon 59: 127-135.
- Medel R, Guzmán G, Chacón S. 1999. Especies de macromicetos citados de México XI. Ascomycetes, parte III: 1983-1986. Acta Bot. Mex. 46: 57-72.
- Pérez-Silva E. 1973. El género *Daldinia* (Pyrenomycetes) en México. Bol. Soc. Mex. Mic. 1: 51-58.
- Pérez-Silva E. 1975. El género *Xylaria* (Pyrenomycetes) en México. Bol. Soc. Mex. Mic. 9: 31-52.
- Pérez-Silva E. 1977. Algunas especies del género *Cordyceps* (Pyrenomycetes) en México. Bol. Soc. Mex. Mic. 11: 145-153.
- Pérez-Silva E. 1978. Nuevos registros del género *Cordyceps* (Pyrenomycetes) en México. Bol. Soc. Mex. Mic. 12: 19-25.
- Pérez-Silva E. 1983. Distribución de algunas especies del género *Hypoxyylon* (Pyrenomycetes) en México. An. Inst. Biol., Univ. Nal. Autón. Méx. 54: 1-22.
- Pérez-Silva E, Aguirre-Acosta E, Herrera T. 1983. Distribución e importancia de algunas especies de *Hypomyces* (*Hypocreales*) en México. An. Inst. Biol., Univ. Nal. Autón. Méx. 54: 203-218.
- Pompa-González A, Cifuentes J. 1991. Estudio taxonómico de los *Pezizales* de los estados de Guerrero, Hidalgo, Estado de México y Michoacán. Rev. Mex. Mic. 7: 87-112.
- Rogers JD. 1981. *Sarcoxyylon* and *Entonaema* (*Xylariaceae*). Mycologia 73: 28-61.
- Rogers JD. 1984. *Xylaria cubensis* and its anamorph *Xylocoremium flabelliforme*, *Xylaria allantoidea* and *Xylaria poitei* in continental United States. Mycologia 76: 912-923.
- Rogers JD. 1986. Provisional key to *Xylaria* species in continental United States. Mycotaxon 26: 85-97.
- Rubio-Bustos SY, Guzmán-Dávalos L, Navarrete-Heredia JL. 1999 [2000]. Especies

- entomopatógenas de *Cordyceps* (Fungi, Ascomycotina) en México. Bol. Inst. Bot. (Universidad de Guadalajara) 7(1-3): 135-157.
- Rzedowski J, McVaugh R. 1966. La vegetación de Nueva Galicia. Contr. Univ. Michigan Herbarium 9: 1-123.
- San Martín F, Lavín P. 1997. Datos sobre los géneros *Entonaema* y *Ustulina* (Pyrenomycetes, *Xylariaceae*). Acta Bot. Mex. 40: 25-35.
- San Martín F, Rogers JD. 1989. A preliminary account of *Xylaria* of Mexico. Mycotaxon 34: 283-373.
- San Martín F, Rogers JD. 1995. Notas sobre la historia, las relaciones de hospedante y distribución del género *Xylaria* (Pyrenomycetes, *Sphaeriales*) en México. Acta Bot. Mex. 30: 21-40.
- San Martín F, Ju Y-M, Rogers JD. 1999. Algunas especies de *Hypoxyton* (Pyrenomycetes, *Xylariaceae*) en México. Acta Bot. Mex. 47: 31-53.
- San Martín F, Lavín P, Rogers JD. 2001. Some species of *Xylaria* (Hymenoascomycetes, *Xylariaceae*) associated with oaks in Mexico. Mycotaxon 79: 337-360.
- Spooner B. 2001. The larger cup fungi in Britain- part 3. The genera *Peziza* and *Plicaria*. Field Mycology 2: 51-59.
- Welden AL, Lemke PA. 1961. Notas sobre algunos hongos mexicanos. Bol. Soc. Bot. Mex. 26: 1-24.
- Zarco JF. 1981. Contribución al conocimiento de la distribución ecológica de los hongos, (principalmente macromicetos) en el Valle de México, basado en los especímenes depositados en el Herbario ENCB. Rev. Mex. Mic. 2: 41-72.

***Monacrosporium multiseptatum*,
a new predacious fungus from China**

HONGYAN SU^{1,2**}, YAN LI¹, MINGHE MO^{1**} & KEQIN ZHANG^{1*}

kqzhang111@yahoo.com.cn

¹Laboratory for Conservation and Utilization of Bioresources
Yunnan University, Kunming 650091, P.R. China

²Department of Biology and Chemistry, Dali College, Dali 671000, P.R. China

Abstract—*Monacrosporium multiseptatum*, a new predacious species, is described from Yunnan Province, China. The fungus is characterized by its simple, unbranched conidiophores and elongate fusiform to straight clavate conidia with 4–9 septa (usually 6–7) and a size of 67.5–132.5 (91.6) × 13.8–17.5(15.5) μm. The fungus captures nematodes by stalked adhesive knobs and forms spherical to ellipsoidal chlamydospores in older culture.

Key words—nematode-trapping fungi

Nematode-trapping fungi have been studied worldwide for their potential applications as bio-control agents and their unique predatory habits. Usually, these predacious hyphomycetes are assigned to the genera *Arthrobotrys* Corda (Corda 1839), *Dactylella* Grove (Grove 1884), and *Monacrosporium* Oudem. (Oudemans 1885) based on the morphology of their conidia, conidiophores, and trap devices (Subramanian 1963, Cooke & Dickinson 1965, Castaner 1968, Schenck et al. 1977, Oorschot 1985, Zhang et al. 1994, Rubner 1996, Miao et al. 2003).

During a survey of these fungi in Yunnan Province, China in 2003, soil was sampled and subsamples were sprinkled onto 2% corn meal agar (CMA) plates and challenged with free-living nematode (*Panagrellus redivivus*). After incubation for 2–4 weeks at 25°C, the plates were examined under a dissecting microscope. In the cultures isolated, an unusual species of the genus *Monacrosporium* was found. The culture was inoculated on 2% CMA and incubated at 28°C for 14–30 days and determined based on measurements of taxonomic characters. Trap formation was induced in a 10-day old culture by removing a 2 cm² piece of agar from the center of water agar (WA) plate to create an open space. About 200 nematodes (*Panagrellus redivivus*) were added the free space after the mycelia emerged from the cut margin. Microscopic photographs were taken from fresh living material mounted in water using an Olympus BX51 microscope. After comparing with the known species, we confirm that the culture represents a new taxon, which we name *Monacrosporium multiseptatum*.

** The authors contributed equally to this work.

Monacrosporium multiseptatum H.Y Su et K. Q. Zhang **sp. nov.** (Figs 1-14)

Coloniae in agar CMA *albidae*, *post 7 dies* 25°C 6 cm diam. *Mycelium sparsum*, *hyphis septatis, ramosis*, 1.75–2.5 μm *latis*. *Conidiophora erecta simplicia*, 6–9 *septata*, 170–260 μm *longa*, 2.5–2.75 μm *lata ad basim*, 1.75–2.0 μm *lata ad apicem*. *Conidia hyalini, vulgo fusiformis, basi truncatis* 4–9 *septatis, praecipue* 6–7 *septatis*, 67.5–132.5 (91.6) $\times$ 13.8–17.5 (15.5) μm . *Inprimis bullis tenacibus globosis* 11.25 μm *longis*, 10 μm *crassis*. *Chlamydosporis in culturis vetustioribus, globusae ad ellipsoidae*, 5–8 $\times$ 4–6 μm .

Etymology: The species epithet refers to the septate characteristic of conidia.

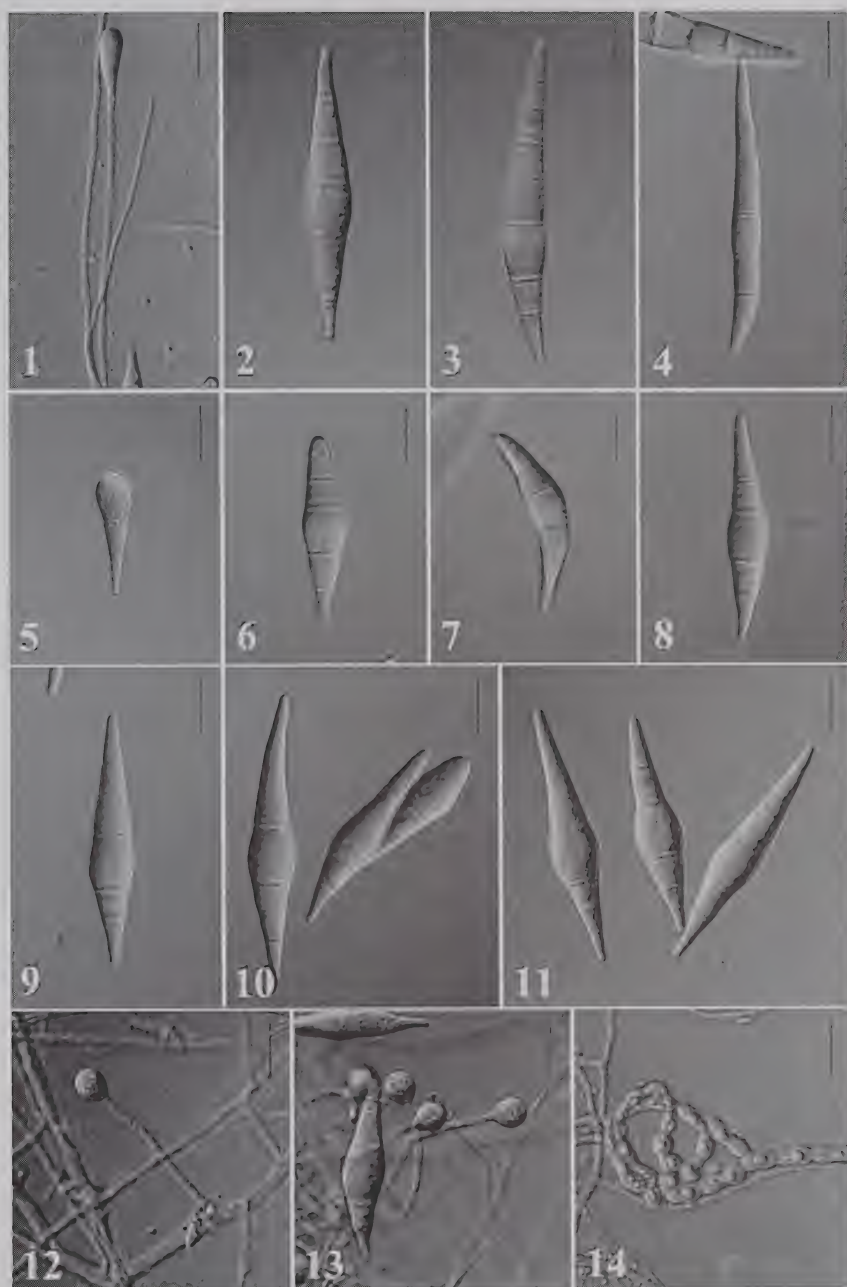
Holotype: YMF1.00127D, Yunnan Province, China. The holotype and its culture (YMF1.00127) are deposited in the Laboratory for Conservation and Utilization of Bioresources of Yunnan University.

Colonies on CMA plates growing quickly, attaining 6 cm diam. in 7 days at 25°C. Mycelium spreading, vegetative hyphae hyaline, septate and branched, mostly 1.75–2.5 μm wide. Conidiophores (Fig 1) erect, simple, septate, 170–260 μm long, 2.5–2.75 μm wide at the base, gradually tapering upward to a width of 1.75–2.0 μm at the tip, bearing a single conidium on the tip of conidiophores, occasionally two conidia. Conidia (Figs 2–11) colorless, elongate fusiform to straight clavate, sometimes apparently curved (Figs 3, 7), narrowly round at the distal end, tapering towards the narrow truncate at the base, somewhat constricted at septa (Figs 8–11), 67.5–132.5(91.6) $\times$ 3.8–17.5(15.5) μm , 4–9 septate, mainly 6–7 septate. The proportion of conidia with 4, 5, 6, 7, 8 and 9 septa accounts for 1.8%, 3.6%, 23%, 45%, 25.1% and 2% respectively. In the presence of nematode the fungus forms stalked adhesive knobs which are unicellular, subspherical. The knob usually 11.25 μm long, 10 μm wide, with a stalk of 20–67.5 μm . Chlamydospores spherical to ellipsoidal, intercalary, about 5–8 $\times$ 4–6 μm (Fig 14).

M. multiseptatum resembles but distinctly differs from two nematode-trapping fungi, *M. haptotylum* (Drechsler) X.Z. Liu & K.Q. Zhang (Drechsler 1950, Liu & Zhang 1994) and *M. ellipso sporum* (Preuss) R.C. Cooke & C.H. Dickinson (Preuss 1851, Cooke & Dickinson 1965) in conidial shape and kinds of predacious device. *M. multiseptatum* produces larger conidia [67.5–132.5(91.6) $\times$ 3.8–17.5(15.5) μm] and more septa (usually 6–8) than *M. haptotylum* [33–50 (43.7) $\times$ 7.4–13.3 (10.7) μm , mainly 4-septate] and *M. ellipso sporum* [37.5–62 (48.3) $\times$ 8.7–19.3 (13) μm , often 4-septate]. Additionally, *M. multiseptatum* does not form denticles on the apex of conidiophores, while *M. haptotylum* and *M. ellipso sporum* often produce two to five short branches near the apex. The fungus also resembles *M. yunnanense* K.Q. Zhang, X.Z. Liu & L. Cao (Zhang et al. 1996) with respect to conidial shape, but the latter produces smaller conidia [34–81 (47.3) $\times$ 8.5–12.5 (10.2) μm] and forms adhesive knobs and non-constricting rings when challenged with nematodes.

Acknowledgments

We appreciate Professor Liu Meihua, Dr. ZhuLiang Yang for correction of the Latin diagnosis and Dr Tao Li, Dr Lee ShanWoo and Yu'e Hao for their revision on the manuscript, and pre-submission peer reviewers ShiDong Li and XueFeng Liu. This work was jointly supported by the projects from NSFC (39860006, 30230020), Ministry of Science and Technology of P. R. China (2003CB415102, 2002BA901A21), and Department of Science and Technology of Yunnan Province (2000C0012Z, 2003RC03, 2004C0001Q).



Figs 1-14 *Monacrosporium multiseptatum*. Fig 1. Conidiophores. Figs 5-6 Immature conidia. Figs 2-4, 7-11. Mature conidia. Figs 12-13 Adhesive knobs. Fig 14 Chlamydospores. bar=20 μ m.

Literature Cited

- Castaner D. 1968. A conidiobolus-like fungus destroying nematode in Iowa. *Mycologia* 60: 440-443.
- Cooke RC, Dickinson CH. 1965. Nematode-trapping species of *Dactylella* and *Monacrosporium*. *Trans. Brit. Mycol. Soc.* 48: 621-629.
- Cordeau ACJ. 1839. *Pracht-Flora europäischer Schimmelbildungen*. Leipzig, Germany.
- Drechsler C. 1950. Several species of *Dactylella* and *Dactylaria* that capture free-living nematodes. *Mycologia* 42:1-79.
- Grove WB. 1884. New or noteworthy fungi. *J. Bot.* 22: 195-201.
- Liu XZ, Zhang KQ. 1994. Nematode-trapping species of *Monacrosporium* with special reference to two new species. *Mycol. Res.* 98: 862-868.
- Miao ZQ, Liu XZ, Li SD, He MX. 2003. *Dactylella pseudoclavata* sp. nov., a new nematode-trapping fungus. *Can. J. Bot.* 81: 1-5.
- Oorschot CAN VAN. 1985. Taxonomy of the *Dactylaria* complex. V. A review of *Arthrobotrys* and allied genera. In: *Taxonomy in the Dactylaria complex, IV-VI*, Hoog GS DE (ed.). *Stud. Mycol.* 26: 61-96.
- Oudemans CAJA. 1885. *Aanwinsten voor de flora mycologica van Nederland*. Ned. Kruidk. Archf, Ser. 2(4):236-257.
- Preuss GT. 1851. Uebersicht untersuchter Pilze, besonders aus der Umgegend von Hoyerswerda. *Linnaea* 24: 99-153.
- Rubner A. 1996. Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. *Stud. Mycol.* 39: 1-134.
- Schenck S, Kendrick WB, Pramer D. 1977. A new nematode-trapping species and a revaluation of *Dactylaria* and *Arthrobotrys*. *Can. J. Bot.* 55: 977-985.
- Subramanian CV. 1963. *Dactylella*, *Monacrosporium* and *Dactylina*. *J. Indian Bot. Soc.* 42: 291-289.
- Zhang KQ, Liu XZ, Cao L. 1994. A review of *Dactylella* and a new species. *Mycosystema* 7: 111-118.
- Zhang KQ, Liu XZ, Cao L. 1996. Nematophagous species of *Monacrosporium* from China. *Mycol. Res.* 100: 274-276.

***Verticimonosporium verticale* sp. nov. from Jiangxi Province, China**

MU WANG^{1,2} LI-MEI ZHANG^{1,3} XING-ZHONG LIU¹

liuxz@sun.im.ac.cn

¹ Key Laboratory of Systematic Mycology & Lichenology
Institute of Microbiology, Chinese Academy of Sciences
P.O. Box 2714, Beijing 100080, China

² Agriculture and Animal Husbandry College of Tibet
Linzhi, Tibet 860000, China

³ Graduate School of the Chinese Academy of Sciences
Beijing 100039, China

Abstract—A new species, *Verticimonosporium verticale*, is described and illustrated based on the distinctive characteristics of having mature conidium singly positioned at a right angle to the phialide tip and cylindrical to ellipsoidal conidia. The differences of the new species from other *Verticimonosporium* species and close-related hyphomycetes are briefly discussed.

Key words—hyphomycetes, taxonomy

Introduction

Matsushima (1971) erected the genus *Verticimonosporium* based on the type species, *V. diffractum* Matsush., from decaying leaf of *Cocos nucifera* in Papua-New Guinea. Subsequently *V. ellipticum* Matsush. collected from Canada was added into the genus (Matsushima 1975). It is characterized by particularly swollen phialidic conidiogenous cells which are discrete in terminal and intercalary whorls and producing hyaline, aseptate conidia solitarily borne on phialides (Matsushima 1971, 1975; Gams et al. 1998). In the study of nematophagous fungi from soil in China, an interesting fungus was isolated from Jiangxi Province. The general morphological characteristics of slow growth, flask-shaped phialides clustering in regular terminal and intercalary whorls on the aerial hyphae fit the generic concept of *Verticimonosporium*. However, the mature conidium singly positioned at a right angle to the phialide tip easily distinguishes this isolate from other two known species in the genus. Thus, a new species, *Verticimonosporium verticale* M. Wang, L.M. Zhang & X.Z. Liu, is proposed.

Materials and Methods

The soil sample was collected from Lushang Mountain, Jiangxi province, China, in April 2003. The fungus was isolated by the sprinkle method (Barron 1977) and purified by picking up the single conidia from the phialides on the aerial hyphae. The isolate was

cultured on PDA (Potato dextrose agar; Oxoid, UK), MEA (Malt extract agar; Oxoid, UK) and CMA (Corn meal agar; Oxoid, UK) plates at 22°C. Details of fungal colony and morphology were studied and recorded after incubation of ten days. All microscopic characteristics were measured from more than 50 individuals in water mounts.

Results

Verticimonosporium verticale M. Wang, L.M. Zhang & X.Z. Liu, *sp. nov.*

Fig. 1-2

Etymology: the species is named by the position of mature conidium with phialide tip.

Coloniae in agar PDA *lanatae, albae, reversae bubalinae*, 14 mm diam. post 10 dies in 22°C. *Mycelium ex hyphis septatis ramosis hyalinis* 1.9-2.0 μm *latis composum*. *Cellulae conidiogenae terminales vel laterales, monoblasticae, simplices vel verticillatim fasciculatae in hyphis aeriis, hyalinae, ampulliformes*, 5.5-13.3 μm *longae, basi* 3.0-4.5 μm *crassae, ad apicem angustatae* 0.2-0.5 μm *crassae. Conidia singularia, cylindrica vel ellipsoidea, maturitate ad apicem phialidis versus verticaliter posita*, 4.7-8.3 $\times$ 1.8-4.0 μm .



Fig. 1. *Verticimonosporium verticale*. a. Arrangement of conidiogenous cell on hyphum; b-c. Various intercalary and terminal phialides; d. Conidia. Scale bar = 10 μm .

The fungus grows slowly on agar plates, colony diameter reaches 14-18 mm on CMA, 14-21 mm on MEA and 14 mm on PDA at 22°C for 10 days. The colony on PDA is densely floccose, white, reverse usually pale yellowish. Hyphae are hyaline, smooth-

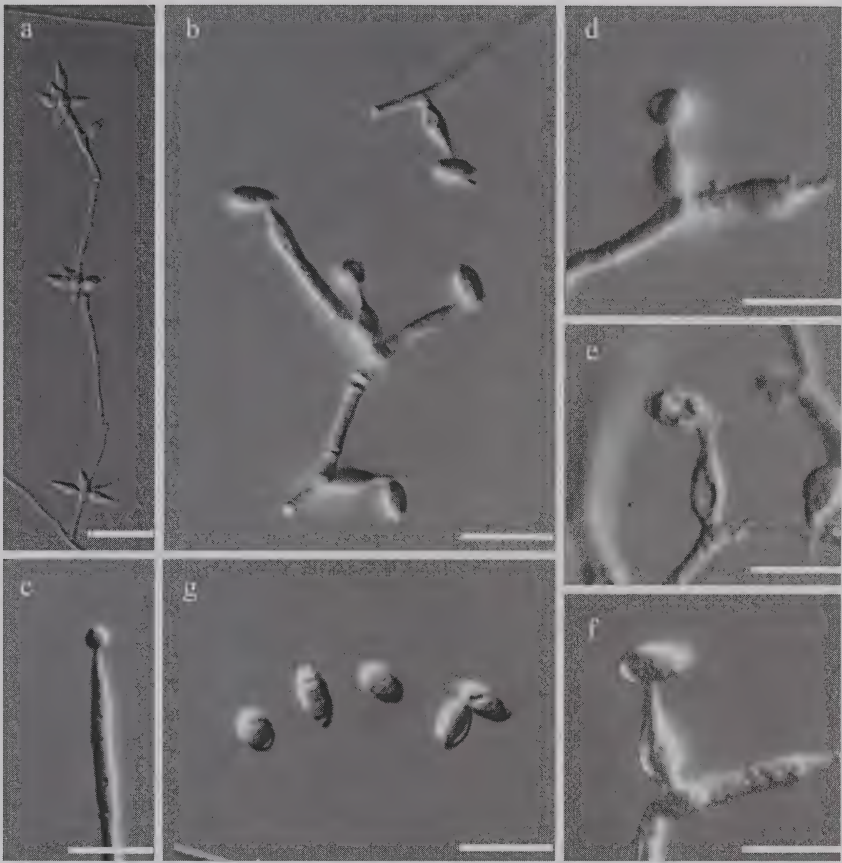


Fig. 2. Microscopic characteristics of *Verticimonosporium verticale*. a. Phialides cluster on the aerial hypha; b. Various phialides; c. Terminal phialide; d-f. Development of conidia on phialides; g. Conidia. Scale bar = $10\mu\text{m}$.

walled, mostly $1.9\text{--}2.0\mu\text{m}$ wide. Conidiogenous cell are hyaline, smooth, easily seceded from hyphae, flask-shaped, swollen near the base, with a narrow tip, occasionally single, but more often 2-5 clustered in regular terminal and intercalary whorls on the aerial hyphae, $5.5\text{--}13.3\times 3\text{--}4.5\mu\text{m}$, with a thin neck, $0.2\text{--}0.5\mu\text{m}$ wide. Conidia are one-celled, solitary, short cylindrical to ellipsoidal, both ends obtusely rounded, straight or slightly curved, $4.7\text{--}8.3\times 1.8\text{--}4.0\mu\text{m}$, positioned at a right angle to the phialide tip after maturity.

Holotype: P. R. China, Jiangxi Province, Lushang Mountain, 11 April 2003, L.M. Zhang, JX03-12-1. Specimen of dried colony and microscope slide was deposited as HMAS 95024 in Herbarium Mycologicum, Institute Microbiologici, Academiae Sinicae (HMAS). Living culture (AS 3.6790) was deposited in China General Microbiological Culture Collection Center.

Discussion

The new species is well assigned into the genus *Verticimonosporium* due to its extremely slow growth on agar plates, typical flask-shaped phialides clustered in regular terminal and intercalary whorls on the aerial hyphae, and hyaline and aseptate conidia solitarily borne on the tip of phialides. *V. verticale* differs from *V. diffractum* in conidial shape. *V. verticale* produces cylindrical to ellipsoidal conidia, while *V. diffractum* produces globose to subglobose conidia (Matsushima 1971). Both *V. verticale* and *V. ellipticum* produce ellipsoidal conidia, but the conidium of *V. verticale* sits at a right angle to the phialide tip after maturity. Unlike most phialide-producing fungi that produce several conidia from each conidiogenous cell, only one single conidium develops per phialide-like conidiogenous cell in *Verticimonosporium*. This feature has been found in only a few other hyphomycetes genera, such as *Verticimonosporium*, *Aphanocladium* W. Gams, *Stanjemonium* W. Gams, O'Donnell, Schroers & M. Chr. and some species of *Sibirina* G. R. W. Arnold (Carmichael et al. 1980, Gams et al. 1998). *Verticimonosporium* differs from the other genera by producing discrete conidiogenous cells in terminal and intercalary whorls; phialides are particularly swollen.

Acknowledgements

We are grateful to Dr. J.Y. Zhuang for help in preparing Latin diagnosis and Drs. W.Y. Zhuang & W.P. Wu for reviewing the manuscript and providing precious suggestions on this paper. This project is supported by the National Natural Science Foundations of China (no. 30270007 and 30230020).

Literature Cited

- Barron GL. 1977. The nematode-destroying fungi. Topic in Mycobiology I. Can. Biol. Publ., Ontario.
- Carmichael JWC, Kendrick WB, Connors IL, Sigler L. 1980. Genera of Hyphomycetes. The University of Alberta Press.
- Gams W, O'Donnell K, Schroers H-J, Christensen M. 1998. Generic classification of some more hyphomycetes with solitary conidia borne on phialides. Can. J. Bot. 76: 1570-1583.
- Matsushima T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea. Osaka, Japan.
- Matsushima T. 1975. Icones Microfungorum a Matsushima lectorum. Kobe, Japan

New and rare lichenicolous fungi and lichens from the North American Arctic

M. P. ZHURBENKO¹, G. A. LAURSEN² & D. A. WALKER²

¹zhurb@MZ3838.spb.edu

Komarov Botanical Institute, Professor Popov, 2
St. Petersburg, 197376, Russia

²University of Alaska Fairbanks, Institute of Arctic Biology
Fairbanks, AK 99775, U.S.A.

Abstract—*Pronectria dillmaniae* and *P. walkerorum* are described as new to science. A new combination, *Flavocetraria minuscula* is introduced. *Biatorella contigua* and *Flavocetraria minuscula* are reported as new to North America, *Pycnothelia papillaria* as new to Alaska and the North American Arctic, *Steinia geophana* as new to the North American Arctic, and *Agonimia tristicula* as new to Alaska.

Key words—Ascomycetes, new species, floristic finds

We report herewith two new species of lichenicolous fungi and a few interesting lichens collected by the first author or obtained by him from the lichen collections of D. A. Walker or the High Latitude Mycological Research Institute's (HLMRI) herbarium of G. A. Laursen. The material was examined using standard microscopic techniques. Microscopic characters were studied using hand made sections or squash preparations mounted in water, 1% Lugol's Iodine solution, 10% KOH, lactophenol cotton blue, lactic acid, or Congo red. Micrographs were taken with a Nikon Coolpix 5400 digital camera. Lichen chemistry was examined with TLC or standard chemical tests with KOH (K), Ca(ClO)₂ (C), Ca(ClO)₂ immediately after KOH (KC), and C₆H₄(NH₂)₂ (P). Measurements of asci and ascospores size and length/width ratio (l/w) have been usually given as: (min.–){X–SD}–X–{X+SD}{–max.}, the former were rounded to the nearest 0.5 µm, where min. and max. are the extreme values, X the arithmetic mean, and SD the corresponding standard deviation. Novelty of the finds was checked in the relevant literature, Internet resources and in the University of Alaska Museum Herbarium (ALA) database. Lichen nomenclature follows Esslinger (2004). Voucher specimens are housed in the Komarov Botanical Institute Herbarium (LE), unless otherwise indicated.

Agonimia tristicula (Nyl.) Zahlbr.

This is a widespread but overlooked boreal-nemoral species, growing on soil, mosses or other lichens, mostly over base-rich rocks, but rarely on rock or nutrient-rich deciduous bark (Diederich & Serusiaux 2000, Hafellner & Turk 2001, Purvis et al. 1992, Santesson 1993). It reaches the alpine belt in montane regions and has recently been discovered in

the Severnaya Zemlya archipelago (unpublished data of M. Zhurbenko), where it may be a relict species. It has been long known only from the northern hemisphere, but was found recently in Australia as well (McCarthy 1991). Recently it was reported as new from British Columbia, Canada (Goward et al. 1994). **NEW TO ALASKA.**

SPECIMENS EXAMINED: USA, S.E. Alaska: northern part of Prince of Wales Is., eastern slope of El Capitan Peak, 56°12' N, 133°17' W, alt. 570 m, on turf soil and detritus above limestone rocks, 12 Aug. 2001, M. Zhurbenko 01226; central part of Prince of Wales Is., near Balls Lake, 55°42' N, 132°50' W, alt. 130 m, on soil above open rocky wall by a road, 12 Aug. 2001, M. Zhurbenko.

***Biatorella contigua* N.S. Golubk. & Piin**

Biatorella contigua is a species characteristic of frost boils in polygonal and spotted tundras. Previously, it was only known from the Taimyr Peninsula and Severnaya Zemlya archipelago, ranging from the southern shrub tundra to the polar deserts (Piin 1977, 1984; Piin & Martin 1978; unpublished data of M. Zhurbenko). *Biatorella contigua* differs from the other terricolous arctic-alpine species of the genus in its well-developed thallus, its large apothecia to 1 mm diam., its tall hymenium to 170 μ m, and its asci containing 50–100 predominantly (sub)globose ascospores. Since the species may well be overlooked in the Arctic, we provide a short description of this specimen. Thallus producing a verruculose-nodulose crust 1–2 mm thick, occasionally film-like at the periphery, predominantly dirty white, opaque, with a rough surface, occasionally intermingled with olive-brownish, gelatinous, translucent and more smooth portions. Apothecia 0.5–1 mm diam., reddish-brown, convex to semiglobose and constricted at the base, sometimes confluent in a few. Epithymenium yellow-brown. Hymenium colourless, I+ blue. Paraphyses not or sparingly branched above, ecapitate, 1–1.5 μ m diam. Hypothecium medium brown. Ascospores globose or more rarely subglobose, 5–7 $\times$ 5–6 μ m, up to 100 per ascus. **NEW TO NORTH AMERICA.**

SPECIMEN EXAMINED: USA, N. Alaska, North Slope, Sagwon, 69°26' N, 148°40' W, alt. 275 m, loess hill with frost boils, on bare frost boil consisting of sandy soil with moss remnants, 7 Aug. 2003, D. Walker.

Flavocetraria minuscula* (Elenkin & Savicz) Ahti, Poryadina & Zhurb., **comb. nov.** **Figure 1*

BASIONYM: *Cetraria cucullata* (Bellardi) Ach. f. *minuscula* Elenkin & Savicz, Trudy Bot. Muz. Imp. Akad. Nauk 8: 43 (1910).

TYPE: Russia, Khabarovsk Region, Dzhugdzhur Range, Chelasin [River], ca. 57° N, 137° E, alt. 400–1000 m, dry peat bog, 21 May 1903, Ir. M. Shchegolev, 1909 (LE).

? **SYNONYM:** *Cetraria cucullata* (Bellardi) Ach. var. *robotnovii* Oksner, Bot. Zhurn. (Kiev) 1(3–4): 47 (1940).

This is a morphologically distinct species (Fig. 1), characterised by slender, erect, tube-like lobes (0.5–)1–2(–3) mm wide and 2–3(–4) cm tall, with convoluted, overlapping and occasionally fused, flexuous, crisped margins and typically helmet-shaped hooked tips which occasionally bear inconspicuous patches of white pruina. No apothecia have been detected. The spot tests with K, C, and P are all negative, but usnic acid and protolichesterinic acid have been identified with TLC. *Flavocetraria minuscula*

is like a miniature morph of *F. cucullata* (Bellardi) Kärnefelt & Thell, which it also matches in thallus chemistry. It differs from that species, however, in having narrower, more tubular lobes with helmet-shaped lobe tips. *Cetraria cucullata* f. *minuscula* was described by A. Elenkin and V. P. Savicz (1910) from a mountain range along the Pacific coast of the Russian Far East. Previously, it was only known from a few scattered coastal and inland localities in northeastern Asia. As opposed to *F. cucullata*, which is a widespread circumpolar arcto-boreal species, *F. minuscula* seems to have an amphi-Beringian distribution (Eastern Siberia, Chukotka, Interior Alaska), being mostly confined to boreal forests, both on mountains and in lowlands. One find is from the tundra zone, though *F. minuscula* is most probably absent from the High Arctic. Indeed, specimens from Franz Josef Land, Severnaya Zemlya, Taimyr Peninsula, and annotated as "f. *minuscula*" in the herbarium LE, have proved to be just small morphs of *F. cucullata*. In the interior of Alaska, *F. minuscula* was observed to be locally rather abundant, forming distinct patches among "normal" *F. cucullata*. It grows in mesic

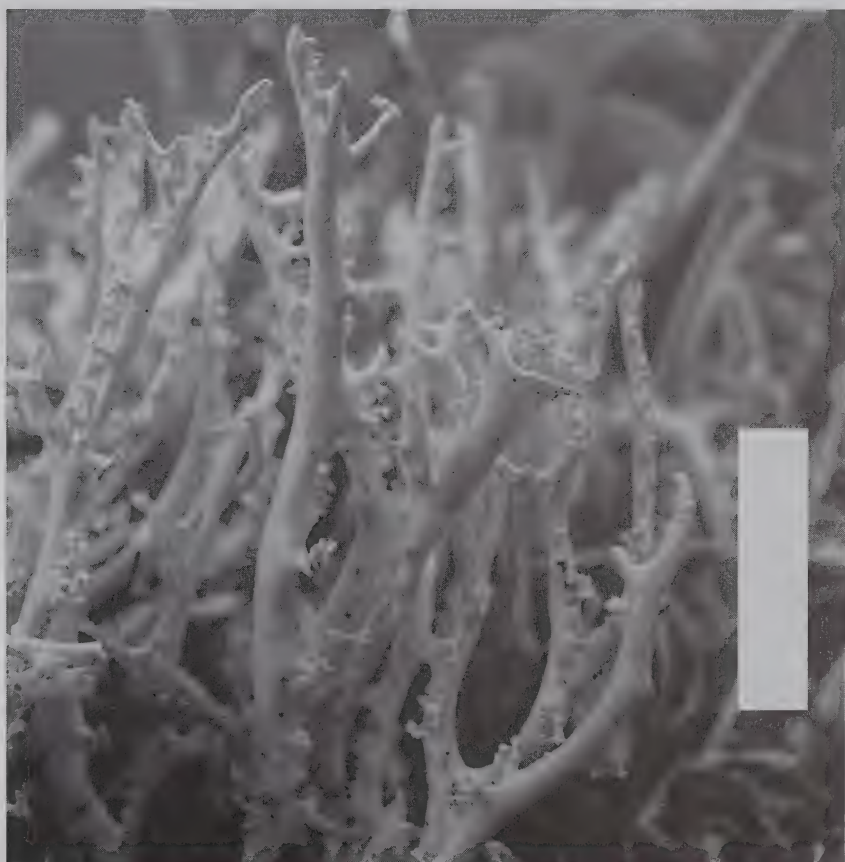


Fig. 1. *Flavocetraria minuscula* (Zhurbenko 04295), habitus. Scale = 1 cm.

conditions on soil, mostly within lichen-moss carpets, and was once found over a rotten mossy log imbedded in the soil. *Cetraria cucullata* var. *rabotnovii*, described from southern Sakha Republic (Yakutiya) (Oksner 1940), is most probably a synonym of *F. minuscula*. We have not found the type of the variety, but its protologue matches *F. minuscula* very well. More data on this species and its range will be given in another paper, which is being prepared by Teuvo Ahti (Helsinki) and Lena Poryadina (Yakutsk).
NEW TO NORTH AMERICA.

SPECIMENS EXAMINED: USA, Interior Alaska: Denali National Park and Preserve, 200 km S. of Fairbanks, near C-camp by the Rock Creek trail, 63°43' N, 148°57' W, alt. 650–700 m, mesic dwarf-shrub-lichen-moss *Picea glauca* mixed forest, on soil in lichen-moss carpet, 16 Aug. 2004, M. Zhurbenko 04359 (KPABG, LE); *ibid.*, 17 Aug. 2004, M. Zhurbenko 04204 (H, LE); *ibid.*, rock outcrops with *Picea glauca* forest, on soil in lichen-moss carpet, 20 Aug. 2004, M. Zhurbenko 04165; Fairbanks area, Chena River State Recreation Area at Mi. 29 Chena Hot Springs Road, southeast of the Rosehip Campground on a southern terrace of the Chena River, 65°21' N, 146°16' W, dwarf-shrub-lichen-moss wetland with sparse *Picea mariana*, on soil in lichen-moss carpet, 29 Aug. 2004, A. Carroll & M. Zhurbenko 04295, 04296, 04297, 04300. — Russia: Khabarovsk Territory (see type); Khabarovsk Territory, Dzhugdzhur Range, Isynyakan River, right tributary of Vatoma [Batomga] River which is left tributary of Maya River, ca. 57° N, 136° E, 28 June 1912, F. V. Sokolov 591; Chukotskii Avtonomnyi Okrug, Chukchi Peninsula, Kresta Bay, vicinities of Egvekinot settlement, mountain stream valley, on soil, 17 Aug. 1977, I. I. Makarova 174.

Fuscopannaria viridescens P.M. Jørg. & Zhurb.

This recently described arctic-alpine species is still known in North America from only a few scattered localities (Jørgensen & Zhurbenko 2002). Reported here is an additional find located about 140 km west of the species type locality.

SPECIMEN EXAMINED: USA, N.W. Alaska, near Kotzebue, 66°53' N, 162°31' W, alt. 50 m, hilly lowland, on mossy soil in spotty tundra, 1961, B. Neiland.

Pronectria dillmaniae Zhurb. sp. nov.

Figure 2

Fungus lichenicola in thallis Catapyrenium parasiticus. Similis Pronectria terrestris Lowen & Diederich, sed ab ea imprimis differt ascosporis brevioribus, (6–)9–10–11.5(–12) × (4–)5–5.5–6(–7) µm.

TYPE: USA, NW Alaska, 140 km E of Kotzebue, middle Kobuk River, NW margin of the Great Kobuk Sand Dunes, 67°06' N, 159°00' W, alt. 60 m, depression with *Dryas*-moss-lichen vegetation on sand, on *Catapyrenium cinereum* (Pers.) Körb. (thallus), 13 Aug. 2000, M. Zhurbenko 00462 (LE 210331, holotype).

ILLUSTRATIONS: Fig. 2.

DESCRIPTION: Ascomata perithecia, obpyriform, (100–)150(–200) µm diam., (125–)200(–250) µm tall, with truncate papilla 50–70 µm diam., pores not seen, aetose, intensively orange- or brownish-red throughout, immersed with only the ostiolar area exposed, scattered. Peridium ca. 30 µm thick, composed of one layer of more or less elongated cells 5–15 × 2–5 µm in vertical section, yellowish brown to orange in squash preparation, not changing colour in lactic acid or KOH. Ostiolar filaments dense, interascal filaments sparse, ca. 2 µm diam., moderately branched. Centrum with

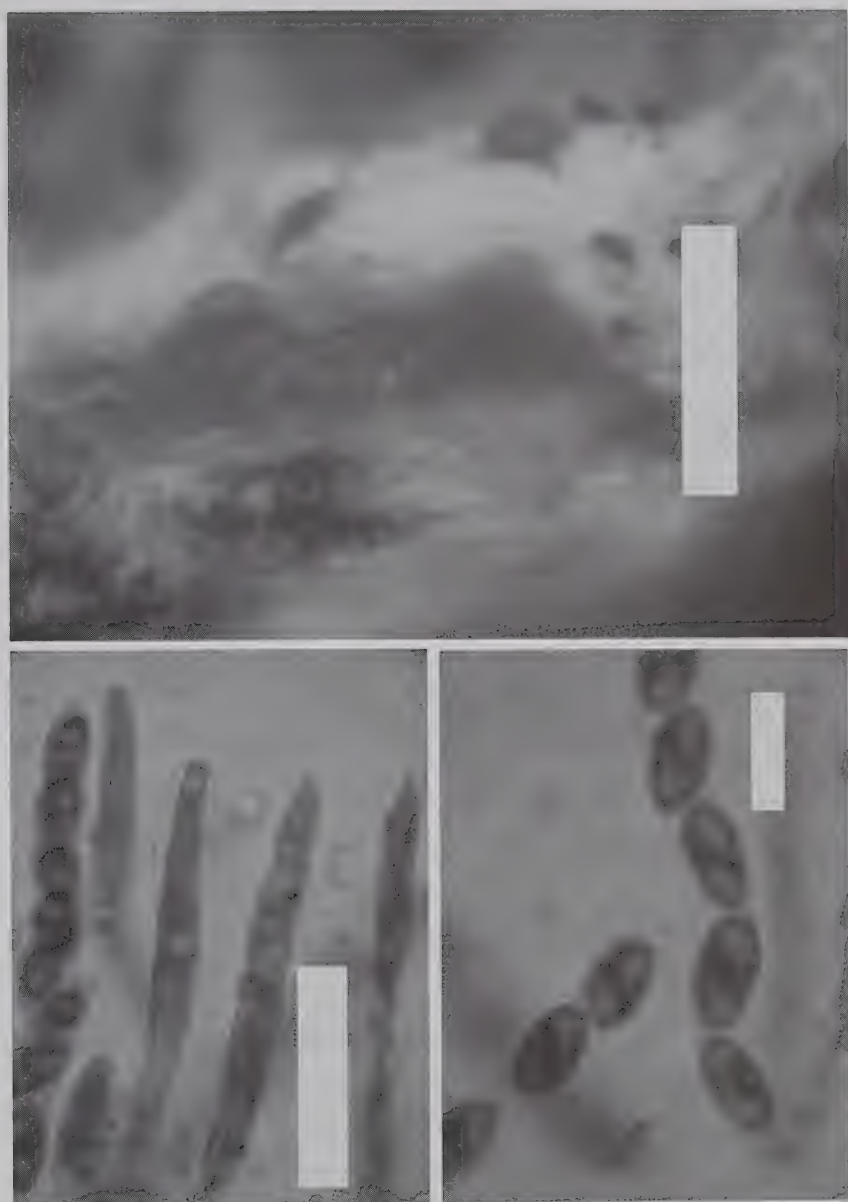


Fig. 2. *Pronectria dillmaniae* (A, holotype; B, C, Zhurbenko 00200): A, perithecia in cross section; B, asci in cotton blue; C, ascospores in cotton blue. Scales: A = 250 μm ; B = 30 μm ; C = 10 μm .

numerous orange oil droplets. Asci unitunicate, cylindrical, with truncate apices, (50–)62–70–77.5(–80) $\times$ 6–7–8 μm ($n=33$, in water or cotton blue), 8-spored. Ascospores colourless, mostly elliptic, occasionally narrowly elliptic or subglobose, 1-septate or rarely simple (when subglobose), not constricted at the septum, (6–)9–10–11.5(–12) $\times$ (4–)5–5.5–6(–7) μm , $l/w = (1-)1.6-1.9-2.1(-2.8)$ ($n=122$, in water or cotton blue), granulate, uniseriate and usually overlapping. Anamorph not seen.

ETYMOLOGY: Dedicated to Karen Dillman in recognition of her contribution to the study of Alaskan lichens and help in collecting type material of this species.

MATRIX AND BIOLOGY: The fungus grows on the thallus of *Catapyrenium cinereum* (Verrucariaceae, Verrucariales) causing strongly bleached patches.

DISTRIBUTION: The new species is known only from the type locality, which is situated within a peculiar sand dunes ecosystem at the northern limit of the taiga zone.

DISCUSSION: *Pronectria dillmaniae* is distinguished from most species in the genus by its short ascospores. It is probably most similar to *Pronectria terrestris* which itself grows on a squamulose terricolous lichen (*Thrombium*, Thrombiaceae, Ascomycota inc. sed.). The latter species is distinguished by its very pale, red to yellowish ascomata, narrowly clavate, shorter and wider asci 60–70 $\times$ 8–10 μm , smooth and longer ascospores 12–17 $\times$ 5.5–7 μm , $l/w = 2.3$, which are biseriate in the middle of an ascus (Lowen & Diederich 1990). *Pronectria dealbans* (Müll. Arg.) Etayo & Breuss, colonizing *Endocarpon loscosii* Müll. Arg. (also Verrucariaceae), is another species known on squamulose lichens growing on soil. It can readily be distinguished from *Pronectria dillmaniae* by its inflated, shorted and wider asci 55–60 $\times$ 11–14 μm and longer ascospores (13–)16–21(–24) $\times$ 5–7.5 μm , which are constricted at the septum (Etayo & Breuss 1996). No nectrioid fungi have been previously reported from *Catapyrenium*, but three more species are known to occur on other genera in the Verrucariaceae, viz. *Pronectria verrucariae* (Vouaux) Lowen, *Nectria tatrensis* Alstrup, and *Nectriopsis indigens* (Arnold) Diederich & Schroers. All of them are readily distinguished from the new species by the following characters: *Pronectria verrucariae* has 2- to 4-spored asci and longer ascospores, 16–21 $\times$ 5–7 μm , which are pale orange at maturity (Rossman et al. 1999); *Nectria tatrensis* has perithecia covered by short white hyphae and bigger ascospores, (15.5–)19–22 $\times$ 8.5–9 μm (Alstrup 1996); *Nectriopsis indigens* has hairy ascomata, often 4-spored asci, and bigger ascospores, 12–19 $\times$ 6–9 μm (Clauzade et al. 1989, Etayo 1998).

ADDITIONAL SPECIMENS EXAMINED: USA, N.W. Alaska, 140 km E of Kotzebue, middle Kobuk River, Great Kobuk Sand Dunes, 67°05' N, 158°58' W, alt. 50 m, depression with spotty *Dryas*-lichen vegetation on sand, on *Catapyrenium cinereum* (thallus), 2 Aug. 2000, M. Zhurbenko 00200 (LE 210321); same locality, depression with lichen heath with sparse *Picea glauca* on sand, on *Catapyrenium cinereum* (thallus), 4 Aug. 2000, M. Zhurbenko 0059 (LE 210311).

Pronectria walkerorum Zhurb. sp. nov.

Figure 3

Fungus lichenicola in thallus et apotheciis Ochrolechia spp. crescit. Similis Pronectria robergei (Mont. & Desm.) Lowen, sed ab ea imprimis differt ascis majoribus 70–90 $\times$ 5–9 μm , ascosporis partim simplicia, majoribus, (8–)12–14.5–17(–20) $\times$ (4–)5.5–6.5–7.5(–10) μm et hospite diverso (Pertusariales).

TYPE: Canada, North West Territories, Canadian Arctic Archipelago, Prince Patrick Is., 2 km S of Mould Bay weather station, 76°14' N, 119°19' W, polar desert, moist slope below snow bed with vegetated (graminoids, dwarf shrubs, mosses, lichens) mounds, on sterile *Ochrolechia* sp. (thallus) growing on moss remnants, 24 July 2004, D. Walker (LE 210371, holotype).

ILLUSTRATIONS: Fig. 3.

DESCRIPTION: Ascomata perithecia, obpyriform to occasionally subglobose or with flattened bottom, 250–350 μm diam., 250–400 μm tall, with truncate papilla 100–125 μm diam., 100–150 μm tall, pores ca. 20 μm diam., aetose, pale to medium apricot or brownish-orange, pore area usually darker, immersed with only the ostiolar area protruding, scattered. Peridium 20–30 μm thick, orange, not changing colour in lactic acid or KOH. Ostiolar filaments dense, interascal filaments sparse, moderately branched, ecapitate, 1–2 μm diam. Centrum with numerous orange oil droplets. Asci unitunicate, cylindrical, with truncate apices, 70–90 $\times$ 5–9 μm ($n=9$, in cotton blue), with apical ring, 8-spored. Ascospores colourless, mostly narrowly elliptic, occasionally (sub)globose, broadly elliptic, oblong or fusiform, apices usually acute, sometimes rounded, (0–)1-septate, not or occasionally strongly constricted at the septum, (8–)12–14.5–17(–20) $\times$ (4–)5.5–6.5–7.5(–10) μm , l/w = (0.9–)1.8–2.3–2.8(–4) ($n=174$, in water or cotton-blue), markedly granulate (as seen in cotton blue; similar granules are sometimes also seen on walls of asci), usually with large oil guttules, overlapping uniseriate to occasionally entirely or partly biseriate. Anamorph not seen.

ETYMOLOGY: Dedicated to Marilyn and Donald Walker in recognition of their contribution to the study of the Arctic vegetation, and for collecting the holotype of this species.

MATRIX AND BIOLOGY: The fungus grows on healthy-looking thalli of *Ochrolechia androgyna* and *Ochrolechia* spp. (*Pertusariaceae*, *Pertusariales*). No pathogenic effect was observed.

DISTRIBUTION: The species is, so far, known only from North America and Svalbard, where it ranges from the northern taiga to the polar desert.

DISCUSSION: The new species is most similar to *Pronectria robergei*. The latter, however, has an often yellow and paler peridium consisting of two layers, shorter asci (40–)55–63–70 $\times$ 5–6–7(–8) μm ($n=25$) [40–70 $\times$ 8–9(–14) μm according to Rossman et al. (1999)]; always 1-septate, smaller ascospores (11–)12.5–13.5–14.5(–17) $\times$ 3–4–5(–6.5) μm , l/w=(2.1–)2.8–3.4–4.1(–4.7) ($n=83$, in water or cotton blue), [8–16 $\times$ (3–)4–8 μm according to Rossman et al. (1999)], with less prominent granules, different hosts (*Peltigera* and *Solorina* species, *Peltigeraceae*, *Lecanorales*), and causing local bleaching of the host tissues. Another three nectrioid fungi have been previously reported on *Pertusariaceae*: *Pronectria robergei* (on terricolous *Ochrolechia frigida* (Sw.) Lynge), *Nectriopsis indigens* (Arnold) Diederich & Schroers and *Pronectria pertusariicola* Lowen (on *Pertusaria* spp. growing on bark of broad-leaved trees). Occasional reports of *Pronectria robergei* on *Ochrolechia frigida* (Alstrup & Elvebakk 1996, Santesson 1993) may refer to *Pronectria walkerorum*. *Nectriopsis indigens* differs from *Pronectria walkerorum* in its hairy ascomata and often 4-spored asci; this species also mainly grows on various saxicolous lichens not belonging to the *Pertusariaceae* (Clauzade et al. 1989, Etayo 1998). *Pronectria pertusariicola* differs

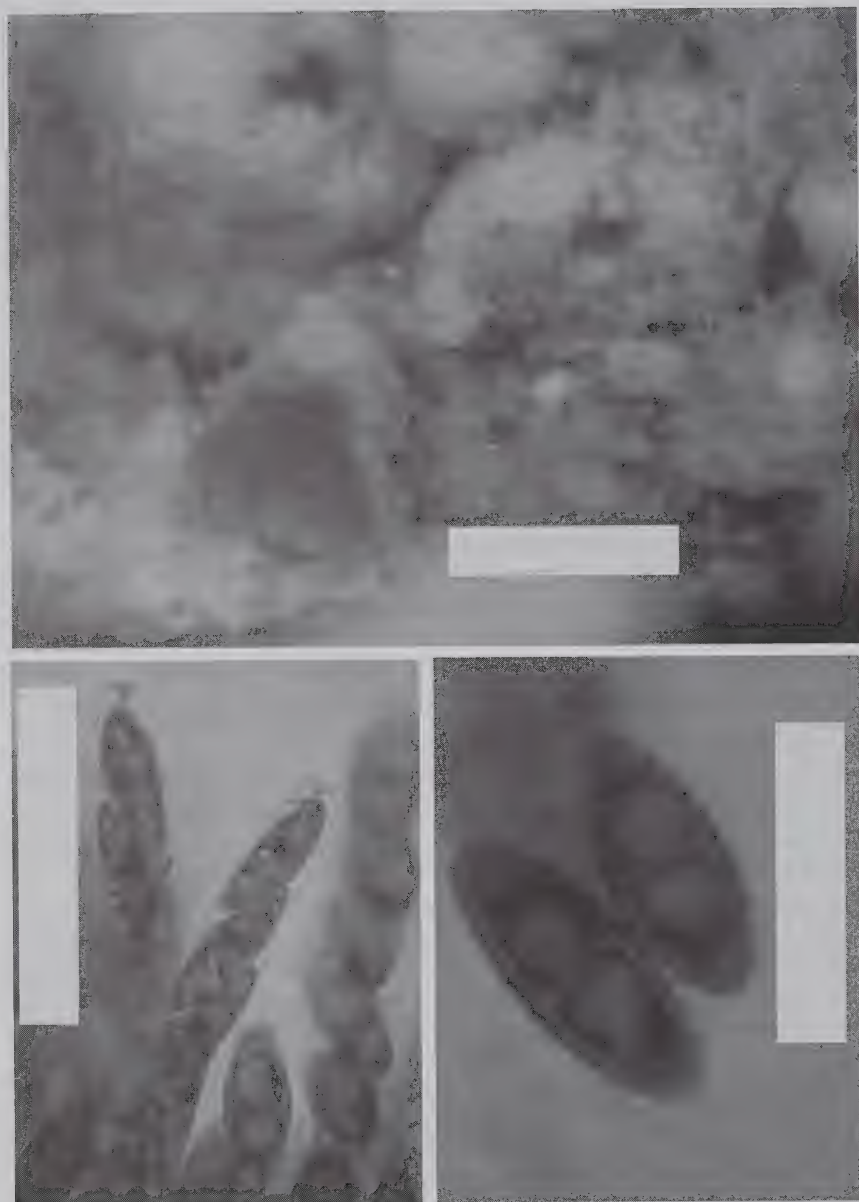


Fig. 3. *Pronectria walkerorum* (A. C. 3 Aug. 2003, Walker; B. Zhurbenko 00458): A, section of perithecium; B, asci with ascospores in cotton blue; C, ascospores in cotton blue. Scales: A = 300 μm ; B = 30 μm ; C = 15 μm .

in forming ascomata in aggregates of 20–100, as well as by its ovoid, 1-septate, longer and narrower ascospores (9–)15–20 × 4.5–5(–6) μm (Rossman et al. 1999). *Pronectria tibellii* (“*tibellae*”) Zhurb. differs from the new species in its smaller ascospores (8–)9.5–11.5–13.5(–16) × 3–3.5–4.5(–5) μm and different hosts (*Cladoniaceae*, *Lecanorales*) (Zhurbenko & Alstrup 2004). *Pronectria echinulata* Lowen differs in its smaller, 100–130(–160) μm diam., orange brown ascomata that become darker in KOH, and are aggregated in raised discoloured areas of the host thallus, as well as in its brownish lateral peridium, its ellipsoid-ovoid, 1-septate, fragile, spinulose, biseriate ascospores, and its different host species (*Physciaceae*, *Lecanorales*) (Rossman et al. 1999).

ADDITIONAL SPECIMENS EXAMINED: USA: N.W. Alaska, 140 km E of Kotzebue, Kobuk River bank near junction with Kavet Creek, 67°07' N, 159°03' W, alt. 50 m, margin of high river terrace, dwarf shrub-lichen-moss shrubby *Picea*-*Betula* forest, on *Ochrolechia androgyna* (Hoffm.) Arnold (thallus) growing on sandy soil, 9 Aug. 2000, M. Zhurbenko 00458 (LE 210391); N. Alaska, Howe Is., 70°19' N, 148°00' W, alt. 10 m, polygonal tundra with sandy frost boils, on sterile *Ochrolechia* sp. (thallus) growing on moss remnants, 3 Aug. 2003, D. Walker (LE 210381); N. Alaska, Prudhoe Bay, Deadhorse, 70°10' N, 148°28' W, alt. 20 m, frost boils in moist non-acidic *Dryas*-*Eriophorum*-moss tundra, on sterile *Ochrolechia* sp. (thallus) growing on mossy soil, 2 July 2002, D. Walker. — Norway, Svalbard, Spitsbergen, Dickson Land, W coast of Billefjorden, 5 km S of Pyramiden settlement, Garmaksla Mt., alt. 200 m, continuous moss carpet below Ca-rocks with bird perches, on sterile *Ochrolechia* sp. (thallus) growing on moss, 23 July 2003, M. Zhurbenko 03185.

SPECIMENS OF *PRONECTRIA ROBERGEI* USED FOR COMPARISON: USA, NW Alaska, 140 km E of Kotzebue, Kobuk River bank near junction with Kavet Creek, 67°07' N, 159°02' W, alt. 30 m, graminoid-dwarf shrub-moss-lichen *Betula* shrubs, on *Peltigera rufescens* (Weiss) Humb. (thallus), 11 Aug. 2000, M. Zhurbenko 00391 (LE 210361). — Russia: Komi Republic, Troitsko-Pechorskii Region, Northern Ural, headwaters of the Pechora River, Pechora-Ilych State Reserve, 132 km ESE of Troitsko-Pechorsk, at junction of Pechora River with Shezhim River, Shezhim cabin, 62°05' N, 58°25' E, alt. 200 m, *Picea* forest, on *Peltigera leucophlebia* (Nyl.) Gyelnik (thallus), 7 July 1997, M. Zhurbenko 97279 (LE 210351); S. Siberia, Altai Mts., Kuderli Lake, alt. 1700 m, *Pinus* forest, on *Peltigera* sp. (thallus), 10 June 1987, Zolotukhin (LE 207388).

Pycnothelia papillaria Dufour var. *papillaria*

Figure 4

Pycnothelia papillaria (Fig. 4) is an uncommon species growing on acidic soil mostly in the northern hemisphere, although it is also known from South America (Osorio et al. 1981). It occurs in eastern North America mostly from Newfoundland (where it is abundant in highly oceanic conditions; pers. comm. of T. Ahti,) to Arkansas (Brodo et al. 2001, Roy 2002, Thomson 1984). In Europe it ranges from the Mediterranean area to the Finnmark province of Norway (ca. 70° N) at the northern extremity of Scandinavia (Dombrovskaya 1970, Llimona & Hladun 2001, Purvis et al. 1992, Sérusiaux et al. 2004, Trass 1978). In the Alps it ranges from lowlands to the nival vegetation belt (Hafellner & Türk 2001). It is rare within the Ural Mts. (Ryabkova 1998) and eastward of the Urals in Asia, being known in Siberia, for example, only from a few localities at the mountains of Sayan, Altai, and boreal Yakutiya (Poryadina 2001; Sedel'nikova 2001a,b, Zhurbenko 2003). Within the Arctic, this species has been previously recorded

only from Chukotka, where it reaches the typical tundra subzone of tundra zone (65°30' N; Nylander 1888) and the southern extremity of Greenland (ca. 60° N; Thomson 1984). NEW TO ALASKA AND AMERICAN ARCTIC.

SPECIMENS EXAMINED: USA: N.W. Alaska, near Kotzebue, 66°53' N, 162°31' W, alt. 50 m, hilly lowland, on graminoid remnants with silty soil in spotty tundra, 1961, B. Neiland; Interior Alaska, Alaska Range, northern foot of Mt. Healy at north-eastern boundary of Denali National Park & Preserve near Healy, 63°50' N, 149°00' W, alt. 600 m, shrub (*Alnus*, *Betula*)-dwarf shrub-moss-lichen mountain tundra, on sandy soil, rather abundant and forming crusts, 29 Aug. 2000, M. Zhurbenko 00330.

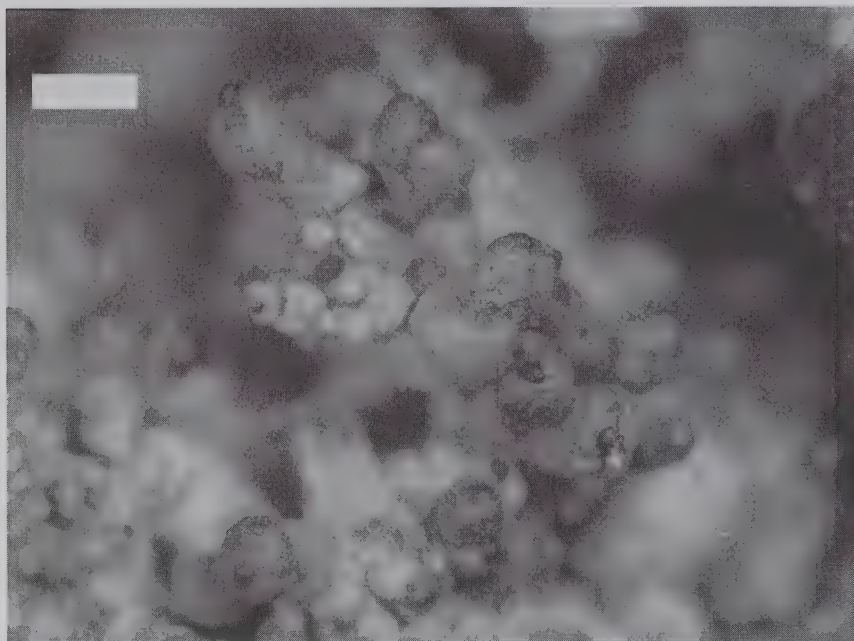


Fig. 4. *Pycnothelia papillaria* (Neiland, 1961), habitus. Scale = 0.5 mm.

Steinia geophana (Nyl.) Stein

This species has been recently reported by Zhurbenko and Laursen (2003) new to Alaska. It was previously known in the Arctic only from the Taimyr Peninsula in Siberia (Piin & Martin 1978). NEW TO AMERICAN ARCTIC.

SPECIMEN EXAMINED: USA, N. Alaska, North Slope, Happy Valley, 69°09' N, 148°51' W, moist sedge-dwarf shrub-moss tussock tundra, frost boil between tussocks, on bare glacial till, 19 July 2001, D. Walker.

Acknowledgements

The authors gratefully acknowledge and thank Bonita Neiland for providing her lichen collection for the HLMRI Herbarium; Amy Carroll for help in collecting *Flavocetraria minuscula* at the

Chena River State Recreation Area; Alan Batten for providing access to the lichen database of the University of Alaska Museum Herbarium; and T. Ahti, T. Goward, I. M. Brodo and M. Cole for valuable comments on the paper. Funding was provided by ERDC/CRREL under Contract No. W913E5-04-C-0002, WDBN/MSWD 0035BE7 and Foreign National Agreement No. MS04-0012C made to the HLMRI. The study of M. Zhurbenko has been also financially supported by the Russian Fund for Basic Researches (RFBR grant № 03-04-49400). National Science Foundation Grant No. OPP-0120736 provided the logistics for the field collections in Canada and northern Alaska.

Literature Cited

- Alstrup V. 1996. *Nectria tatrensis* sp. nov. and other lichenicolous fungi found on the bryolichenological excursion in Slovakia 1993. *Biológia [Bratislava]* 51(1): 13–14.
- Alstrup V, Elvebakk A. 1996. Part 5. Fungi III. Lichenicolous fungi. In A. Elvebakk, P. Prestrud (eds.) A catalogue of Svalbard plants, fungi, algae and cyanobacteria. Norsk Polarinstitutt Skrifter 198: 261–270.
- Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press, New Haven and London.
- Clauzade G, Diederich P, Roux C. 1989. Nelikenigintaj fungoj likenlogaj. Ilustrita determinlibro. *Bull. Soc. Linn. Provence*, num. spec. 1: 1–142.
- Diederich P, Sérusiaux E. 2000. The lichens and lichenicolous fungi of Belgium and Luxembourg. An annotated checklist. *Musée National d'Histoire Naturelle, Luxembourg*.
- Dombrovskaya AV. 1970. Synopsis of the lichen flora of Murmansk Region and north-eastern Finland. *Nauka, Leningrad*. (in Russ.).
- Elenkin AA, Savicz VP. 1910. Enumeratio lichenum in Sibiria orientali a cl. I. Sczegolev anno 1903 lectorum. *Trudy Bot. Muz. Akad. Nauk [St.-Petersburg]* 8: 26–49.
- Esslinger TL. 2004. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: <http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm> (First Posted 1 December 1997, Most Recent Update 17 July 2004). Fargo, North Dakota.
- Etayo J. 1998. Some hypocrealean lichenicolous fungi from Southwest Europe. *Nova Hedwigia* 67(3–4): 499–509.
- Etayo J, Breuss O. 1996. Líquenes y hongos liquenícolas de los Pirineos occidentales y norte de la Península Ibérica, IV. *Cryptogamie, Bryologie-Lichénologie* 17(3): 213–230.
- Goward T, Diederich P, Rosentreter R. 1994. Notes on the lichens and allied fungi of British Columbia. II. *Bryologist* 97: 56–62.
- Hafellner J, Türk R. 2001. Die lichenisierten Pilze Österreichs: eine Checkliste der bisher nachgewiesenen Arten mit Verbreitungsangaben. *Stapfia* 76: 3–167.
- Jørgensen PM, Zhurbenko MP. 2002. Two new, remarkable, arctic species in the lichen genus *Fuscopannaria* (Pannariaceae, lichenized Ascomycetes). *Bryologist* 105(3): 465–469.
- Llimona X, Hladun NL. 2001. Checklist of the lichens and lichenicolous fungi of the Iberian peninsula and Balearic islands. *Bocconea* 14: 1–518.
- Lowen R, Diederich P. 1990. *Pronectria xanthoriae* and *P. terrestris*, two new lichenicolous fungi (*Hypocreales*). *Mycologia* 82(6): 788–791.
- McCarthy PM. 1991. Additional lichen records from Australia 8. *Agonimia tristicula*. *Australasian Lichenological Newsletter* 29: 5.
- Nylander W. 1888. Enumeratio lichenum Freti Behringii. *Bull. Soc. Linn. Normandie*, sér. 4, 1: 198–286.

- Osorio HS, Aguiar LW, Homrich MH. 1981. Contribution to the lichen flora of Brazil VI. New or additional records from Rio Grande do Sul State. *Bryologist* 84: 79–81.
- Oksner AM. 1940. Lishainiki basseinu rik Indigirki, Yani, Leni i pıvdenngo Pribaikallya. *Journ. Bot. Acad. Sci. URSR* 1 (3–4): 31–57.
- Piin T. 1977. The new terricolous lichen from Taimyr Peninsula – *Biatorella contigua* Golubk. et Piin species nova. *Folia Cryptog. Estonica* 7: 1–3.
- Piin T. 1984. Flora and distribution of terricolous lichens in the southern tundra of Taimyr. Pp. 134–172. *In* J. Martin (ed.), *Flora and groupings of lower plants in natural and anthropogenous extreme environment conditions*. Acad. Sci. Eston. SSR, Tallinn. (in Russ., Engl. summ.).
- Piin T, Martin J. 1978. Flora of terricolous lichens. Pp. 101–123. *In* B. N. Norin (ed.), *Ary-Mas*. Nauka, Leningrad. (in Russ.).
- Poryadina LN. 2001. Lichens of “Suntar-Hayata” reserve (Yakutiya). *Novitates Systematicae Plantarum non Vascularium [St.-Petersburg]* 34: 167–176. (in Russ.).
- Purvis OW, Coppins B, Hawksworth DL, James P, Moore DM (eds.). 1992. *The lichen flora of Great Britain and Ireland*. Natural History Museum Publications and British Lichen Society, London.
- Rossmann AY, Samuels GJ, Rogerson CT, Lowen R. 1999. Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, Ascomycetes). *Studies in Mycology* 47: 1–248.
- Roy C. 2002. Confirmation de la présence du lichen fruticuleux *Pycnothelia papillaria* Dufour sur la Moyenne et la Basse-Cote-Nord, Québec, Canada. *Ludoviciana* 30: 58–61.
- Ryabkova KA. 1998. Systematic lichen list of the Urals. *Novitates Systematicae Plantarum non Vascularium [St.-Petersburg]* 32: 81–87. (in Russ.).
- Santesson R. 1993. *The lichens and lichenicolous fungi of Sweden and Norway*. SBT-förlaget, Lund.
- Sedel'nikova NV. 2001a. Lichens of Western and Eastern Sayan. SO RAN, Novosibirsk. (in Russ.).
- Sedel'nikova NV. 2001b. Lichens. Pp. 228–277. *In* *Flora and vegetation of Katun' Reserve (Altai Mts.)*. Novosibirsk. (in Russ.).
- Sérusiaux E, Diederich P, Lambinon J. 2004. Les macrolichens de Belgique, du Luxembourg et du nord de la France. *Clés de détermination*. *Ferrantia* 40: 1–192.
- Thomson JW. 1984. *American Arctic lichens. 1. The Macrolichens*. Columbia University Press, New York.
- Trass HH. 1978. *Pycnothelia*. Pp. 7–8. *In* I. I. Abramov (ed.), *Handbook of the lichens of the U.S.S.R. 5. Cladoniaceae-Acarosporaceae*. Nauka, Leningrad (in Russ.).
- Zhurbenko MP. 2003. New and rare lichen species (Lichenes) from Sakha-Yakutiya Republic and Magadan Region. *Botanicheskii Zhurnal [St.-Petersburg]* 88 (1): 111–118. (in Russ., Engl. summ.).
- Zhurbenko MP, Alstrup V. 2004. Lichenicolous fungi on *Cladonia* mainly from the Arctic. *Acta Univ. Ups. Symb. Bot. Ups.* 34(1): 477–499.
- Zhurbenko MP, Laursen GA. 2003. Lichenicolous fungi from Central Alaska: new records and range extensions. *Bryologist* 106(3): 460–464.

A new species of *Paecilomyces* isolated from the Antarctic springtail *Cryptopygus antarcticus*

P.D. BRIDGE, M. S. CLARK & D.A. PEARCE

pdb@bas.ac.uk

*British Antarctic Survey, Natural Environment Research Council
High Cross, Madingley Rd, Cambridge CB3 0ET, UK*

Abstract — A monophialidic species of *Paecilomyces* was isolated from the Antarctic springtail *Cryptopygus antarcticus* in the peninsular Antarctic. The fungus emerged through the carapace of dead arthropods during incubation at 4°C, and produced colonies on agar media at both 4 and 17°C. The fungus was morphologically similar to a number of existing monophialidic species of *Paecilomyces*, but differed in colony pigmentation, the size of phialides and conidial features. Analysis of the ribosomal DNA internally transcribed spacer (ITS) and 18S subunit sequences showed the fungus to be distinct from other *Paecilomyces* species, and suggested a close relationship with *Cordyceps* species. The new species *Paecilomyces antarcticus* is described.

Key words — entomogenous, Antarctica, Collembola, molecular, ribosomal DNA

Introduction

More than 700 species of fungi have been recorded from the sub-Antarctic and Antarctic region (Bridge & Worland 2004, P.D. Bridge, work in progress). The great majority of these are considered cosmopolitan, and many common filamentous genera and species have been reported. Several species of entomogenous fungi, including species of *Beauveria*, *Verticillium*, *Conidiobolus* and *Neozygites* have been reported from Antarctic sites (Göttlich et al. 2003, Roddam & Rath 1997, Hughes & Lawley 2003, Tosi et al. 2002, Bridge & Worland 2004). With the exception of the report of *Neozygites* sp. (Bridge & Worland 2004), these fungi have been recovered without any discernable arthropod hosts, and their habit and ecology in the Antarctic are largely unknown. The true indigenous Antarctic arthropods are restricted to wingless insects and mites, and these are widely distributed in the maritime and peninsular regions, often associated with moss banks or other vegetation. Springtails (Collembola) largely feed on bacteria and fungi, and have been considered potential vectors for the transmission of entomogenous fungi (Dromph 2001, Dromph & Vestergaard 2002). There are very few reports of natural associations between entomogenous fungi and springtails, and those recorded from temperate regions have largely involved the generalist entomopathogens *Lecanicillium lecanii* (Zimm.) Zare & W. Gams, *Beauveria bassiana* (Bals.-Criv.) Vuill., *Lecanicillium psalliotae* (Treschew) Zare & W. Gams and *Paecilomyces farinosus* (Holmsk.) A.H.S. Br. & G. Sm. (Sitch & Jackson 1997, ARSEF 2004, CBS 2004).

There are also reports of infection by the entomophthoralean fungi *Entomophthora variabilis* (Thaxt.) Sacc. & Traverso, *Conidiobolus coronatus* (Costantin) A. Batko and *Neozygites sminthuri* S. Keller & Steenb. (Balazy 1993, Steenberg et al. 1996, Dromph et al. 2001).

The effect of entomogenous fungi on springtails is also poorly understood. Some studies have suggested that springtails may have natural resistance to entomogenous fungi (Broza et al. 2001), but one recent study has shown that several collembola species can be naturally infected by entomophthoralean species, and infection levels of 12-17% by late summer have been reported (Steenberg et al. 1996, Dromph et al. 2001). There is very limited information regarding the effect of hyphomycete fungi on springtails, but artificial inoculations have suggested that some insect species can survive short exposure times, and that the insects may have a role in the wider dispersal of the fungi (Dromph et al. 2002). However this study also identified differences in pathogenicity between different fungal isolates, with infection by individual isolates of *Beauveria brongniartii* (Sacc.) Petch and *M. anisopliae* (Metschn.) Sorokin leading to around 50% mortality (Dromph et al. 2002).

Reports of fungal pathogens occurring on Antarctic springtail species are limited to those of springtail capturing *Arthrobotrys* species (Drechsler 1944, Onofri & Tosi 1992), although an un-named *Conidiobolus* species has been isolated from moss cushions in continental Antarctica, no host was reported (Tosi et al. 2002). This study was undertaken to determine if culturable entomogenous fungi were present in populations of the Antarctic collembola *Cryptopygus antarcticus* Willem.

Materials and methods

Collection

Initial collections were made from a small bank of *Sanionia uncinatum* (Hedw.) Loeske moss at Rothera Point, Adelaide Island 67° 34'S, 68° 08'W. Moss plants were placed in sterile plastic 28ml Universal containers and shaken. The moss was then removed and dislodged arthropods were collected. Individuals were examined under a binocular dissecting microscope, and dead and morbid individuals were surface sterilised by washing in 70% ethanol for 30 seconds before being transferred to Petri dishes of Potato Dextrose agar (PDA), and incubated at 4 and 17°C.

Slides were prepared in cotton blue in lactic acid and warmed gently prior to microscopic examination

DNA extraction

A small section of fungal mycelium was ground in a 1.5 ml Eppendorf tube using a conical grinder in 0.5 ml prewarmed (60 °C) buffer containing 1% Cetyl trimethyl ammonium bromide, 1M NaCl, 100mM Tris, 20 mM EDTA which had been sterilized and 1% polyvinylpyrrolidone added immediately prior to use. The sample was incubated at 70 °C for 30 minutes and an equal volume of chloroform:isoamyl alcohol (24:1) added. The tube was mixed by inversion. The two phases were separated by centrifugation at 10000xG for 5 mins, and the upper aqueous layer removed to a clean tube. The CTAB/DNA complex was precipitated by addition of 2 volumes of a buffer containing 1% Cetyl trimethyl ammonium bromide, 50mM Tris HCl, 10mM EDTA

and 40 mM NaCl. The tube was then mixed by inversion for 2 minutes. The pellet was collected by centrifugation at 13000xG, the liquid removed and the pellet resuspended in 350 ml of 1.2M NaCl. One volume of chloroform:isoamyl alcohol was then added and the tube mixed by inversion. Phases were separated and the upper aqueous layer was collected as described above. DNA was precipitated through the addition of a 0.6 volume of cold iso-propyl alcohol to form 2 layers. The two layers were then mixed by inversion and incubated at -20 °C for 15 min. The resulting pellet was collected by centrifugation at 13000xG for 20 min, the pellet washed in cold 70% ethanol, centrifuged briefly, and the ethanol removed. The pellet was dried under vacuum and re-dissolved in sterile water.

Table 1. Accession numbers and origins of *Paecilomyces* ITS sequences used for comparisons

Sequence	Name	Reference/other details
AF368802	<i>P. cateniannulatus</i> Z.Q. Liang	EMBL, host=Lepidoptera
AF368799	<i>P. cateniobliquus</i> Z.Q. Liang	EMBL, host=Coleoptera
AB103379	<i>P. carneus</i> (Duché & R. Heim) A.H.S. Br. & G. Sm.	Yokoyama et al. (2004)
AB085886	<i>P. cicadae</i> (Miq.) Samson	Yokoyama et al. (2004)
AY618240	<i>Paecilomyces farinosus</i> (Holmsk.) A.H.S. Br. & G. Sm.	Vasiliauskas et al. (2004)
AB080087	<i>P. farinosus</i>	Yokoyama et al. (2004)
AB083035	<i>P. fumosoroseus</i> (Wize) A.H.S. Br. & G. Sm.	Yokoyama et al. (2004)
AB086629	<i>P. fumosoroseus</i>	EMBL
PGU309339	<i>P. gunnii</i> Z.Q. Liang	EMBL, teleomorph <i>Cordyceps gunnii</i>
PHA309342	<i>P. hawkesii</i> Z.M. Xiao, T.B. Li & Q.T. Chen	EMBL, teleomorph <i>Cordyceps hawkesii</i>
AB099944	<i>P. javanicus</i> (Friedrichs & Bally) A.H.S. Br. & G. Sm.	EMBL
AB103380	<i>P. lilacinus</i> (Thom) Samson	Yokoyama et al. (2004)
AB099511	<i>P. marquandii</i> (Masse) S. Hughes	EMBL
PMI309327	<i>P. militaris</i> Z. Liu	EMBL, teleomorph <i>Cordyceps militaris</i>
AB104884	<i>P. nostocoides</i> M.T. Dunn	Yokoyama et al. (2004)
AB070371	<i>P. tenuipes</i> (Peck) Samson	Yokoyama et al. (2002)
AB086204	<i>P. tenuipes</i>	Yokoyama et al. (2003)
AF033395	<i>P. variotti</i> Bainier	Peterson (2000)
AF368810	<i>Acremonium implicatum</i> (J.C. Gilman & E.V. Abbott) W. Gams	EMBL

DNA amplification

DNA was PCR amplified by the fungal optimised ITS procedure with primers ITS1F and ITS4 (Gardes & Bruns, 1993; White et al., 1990) and universal 18S primers (van Hannen et al, 1999). The PCR products were shotgun cloned into the pGEM-TEasy vector (Promega) and transformed into XL-10 Gold ultracompetent cells

(Stratagene). Positive colonies were picked into 10 μ l sterile distilled water and 1 μ l of this used for PCR amplification using limiting dilutions of dNTPs and primers (SP6 and T7) according to http://fugu.hgmp.mrc.ac.uk/Protocols/Biology/fugu_section2.html#2.1. Products were sequenced directly from the PCR products using a long T7 primer (5' TAATACGACTCACTATAGGGCGA 3'), DYEnamic ET Dye terminator mix (Amersham) and a two stage PCR cycle (95°C, 20 secs; 60°C, 2mins 20 secs; repeated 25 times). Sequences were run on an Amersham MegaBACE 1000 sequencer according to manufacturer's instructions for 100 mins.

Sequence analysis

The final DNA sequences were initially screened through the entire EMBL DNA sequence database with the BLAST-WU programme (Altschul, et al., 1997) run interactively through the EBI website (www.ebi.ac.uk). The sequences were then screened with the FASTA utility (Pearson, 1990) against the EMBL Fungi subset library. Eighteen reference ITS sequences of *Paecilomyces* species included in the EMBL data base were downloaded (Table 1). These sequences were aligned in CLUSTALW (Thompson et al., 1994) and checked manually. The final alignments were compared through PHYLIP in a consensus average distance tree constructed by Neighbour-joining from 100 bootstrap replicates (Felsenstein, 1989) with an ITS sequence from *Acremonium implicatum* as the outgroup.

Results

Initial examination

Twelve springtails were found to be dead or morbid in the initial collection, and these were identified as *Cryptopygus antarcticus*. There were no visible fungal conidia or mycelium on the external surfaces of these individuals.

Culture

After 8 weeks incubation at 4°C fungal mycelium was evident on one insect. This appeared as cottony mycelial growth breaking through the carapace on the back of the individual, and initially this resulted in a strongly fasciculate colony directly on the insect. The insect was dissected into four sections and these were placed on fresh PDA and Malt agar (MA) plates that were incubated at 4°C and 17°C. After 2 weeks the fungus produced white colonies that grew out radially from the initial inoculum. Colonies on MA were initially white and cottony and became strongly velvety and darkened to a light flesh colour with age. The lower part of the colonies extended into the medium causing splitting and buckling of the agar. Colonies reached a diameter of 30mm after 2 months at 4°C, or 5 weeks at 17°C.

Microscopy

Septate mycelium was formed. Conidiophores were absent and conidia were formed on single erect phialides. Phialides were 25-35 μ m in length, tapering from 2-3 μ m at the base to 1-1.5 μ m at the tip. Conidia (2 x 6.5-8 μ m) were hyaline, smooth and bacilliform with truncate, slightly rounded ends. Conidia were plentiful and easily liberated from the ends of the phialides (Figures 1 & 2).

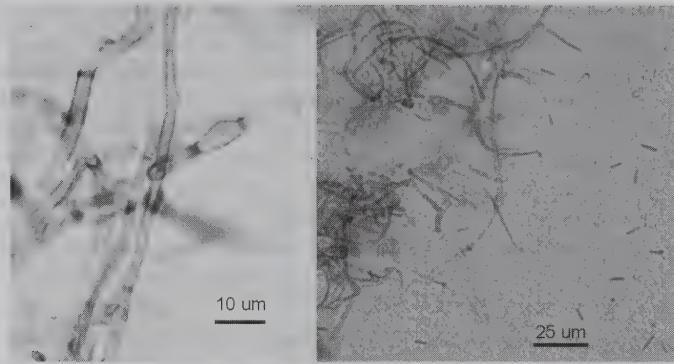


Figure 1. Single phialide Figure 2. Conidia and phialides

Molecular

Amplification with universal 18s primers gave an unambiguous sequence of 565bp at the immediate 5' terminus of the 18s gene. This sequence is deposited at EMBL as AJ879114. A FASTA search gave the best match of *Cordyceps brongniartii* Shimazu at 98.1%. However the first 50 best matches contained 43 sequences from Hypocreales or Hypocrealean anamorphs, including 26 from *Cordyceps* species, all of which showed greater than 97% homology.

Amplification with primers ITS1F and ITS4 gave an unambiguous sequence of 591bp that included 3' and 5' fragments of the small and large subunit genes respectively, and the entire ITS1, 5.8s and ITS2 regions. This sequence is deposited at EMBL as AJ879113. A FASTA search gave the best match to a sequence from *Paecilomyces fumosoroseus* at 85.5%. Three of the first 4 best matches were sequences from *Paecilomyces* species, the fourth being to an unidentified sequence. Other matches were largely to ITS sequences from Hypocrealean anamorphs including *Metarhizium*, *Beauveria* and *Verticillium* species. However overall the matches were fairly low scores, the best 50 ranging from 75.6 to 85.5% identity. The results of the BLAST-WU search differed in that the best matches contained further sequences from *Paecilomyces* species with 5 sequences from *P. fumosoroseus* and one from *P. javanicus* in the best 12 matches. The best matches in the BLAST search gave 86% identity. The ITS alignment with 18 ITS sequences from *Paecilomyces* species placed the springtail fungus with a sequence from *P. fumosoroseus* and *P. javanicus* (Figure 3). This grouping had high bootstrap support in consensus trees, as did the placement of the sequence within a group of *Paecilomyces* sequences.

Taxonomic description

Paecilomyces antarcticus Bridge, M.S. Clark & D.A. Pearce, *sp. nov.*

Coloniae in extracto malti, albae dein carneus, velutinus, reverso albidus dein icterinus. Conidiophora absentia, cellulis conidiogenis monophialidicis, hyalinis, 25-35µm longis, baso 3-4µm, apice 2µm latitudo. Conidia hyalina, bacilliforme, aseptata 6.5-8 x 2µm.

Typus Herb. K(M) 124154

Growth on Malt Agar. Initially cottony, becoming strongly velvety to slightly fasciculate with age. Lower part of colony growing into medium, causing buckling and splitting of agar. Colony white when young, darkening to flesh coloured. Reverse white, darkening with age to grey/brown. Diffusing yellow pigment seen in Malt Agar after 4 months at 4°C, absent on PDA. Growth rate at 4°C slow, colonies reaching 30mm after 2 months. Growth rate moderate at 17°C, colonies reaching 20mm in 3 weeks. Mycelium septate, conidiophores lacking, with phialides occurring singly along the length of the hyphae. Hyphae occasionally terminating in a single phialide. Phialides, tapering from 2-3µm at base, occasionally swollen, to 1-1.5µm at tip. Conidia produced abundantly from apices of phialides. Conidia hyaline, smooth and bacilliform with slightly rounded ends, non-septate 2 x 6.5-8µm, very easily liberated.

Specimen examined: Herb. K(M) 124154 (Type) and culture K(C) 1684. Isolated from *Cryptopygus antarcticus* collected at Rothera Point, Adelaide Island, Antarctica in December 2003

Discussion

Molecular - The 18s data placed *P. antarcticus* in the *Clavicipitaceae* as an anamorph of a *Cordyceps* species. This is unsurprising in that many of the common fungal pathogens of invertebrates have been described with *Cordyceps* teleomorphs. The analysis of the ITS sequence confirms the placement in the *Clavicipitaceae*, and suggests that the fungus is a *Paecilomyces* species.

The tree constructed from the ITS sequences from other *Paecilomyces* species gave high bootstrap support to this placement, and to the separation of these species from *Acremonium* (Figure 3). ITS sequences are very variable within *Paecilomyces*, and this is illustrated by the long branch length between all of the sequences used and the type species *P. variotti*. Similar analyses undertaken with sequences from *Verticillium*, *Hirsutella* and *Beauveria* repeatedly recovered the *P. antarcticus* ITS sequence within groups of *Paecilomyces* sequences (data not shown). The two ITS sequences that gave the best matches were from *P. fumosoroseus* (AB086629) and *P. javanicus* (AB099944), and the *P. antarcticus* ITS sequence grouped with these in the consensus tree. However the *P. fumosoroseus* sequence that was the closest match is anomalous in that it shows only an average 71.9% identity to the 12 other *P. fumosoroseus* sequences deposited in EMBL, whereas these show 94.3% homology with each other (data not shown). The *P. javanicus* sequence is the only one available for that species, and shows 98% identity to the anomalous *P. fumosoroseus* sequence, a finding that suggests that the anomalous sequence may be from a mis-identified strain of *P. javanicus*. Although these two sequences were the closest to the sequence from *P. antarcticus*, the matches were low (85.5%), and the new species is clearly similar to, but distinct from, *P. javanicus*.

The morphological features of the fungus are generally unremarkable, and are similar to those observed for a number of anamorphic genera in the *Clavicipitaceae*. The lack of a conidiophore, together with conidiogenous cells tapering to give a long neck, are features of several genera including *Hirsutella*, *Acremonium*, some *Verticillium* species and monophialidic *Paecilomyces* species. Phialides were very variable in shape and size, ranging from flask shaped with distinct necks to very elongated cells (see Figure 1). Conidia were dry, produced singly or in short chains, and were easily liberated, features that further reduce the number of available genera. The genus *Paecilomyces*

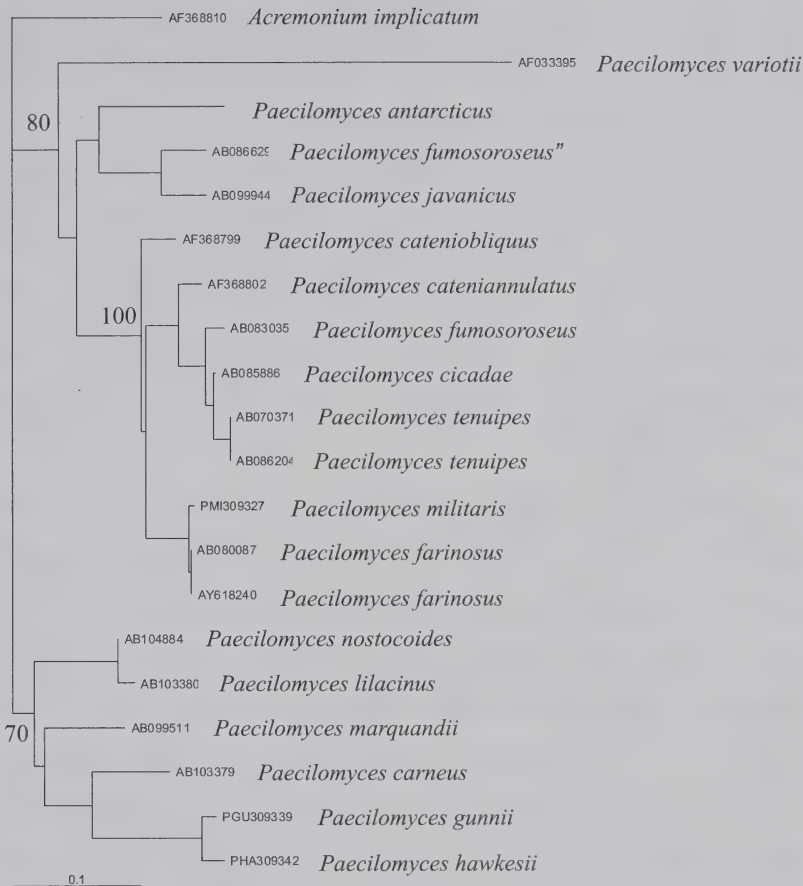


Figure 3. Neighbour joining tree for *Paecilomyces* ITS sequences rooted with *Acremonium implicatum*. Numbers are bootstrap values for major groupings in consensus trees.

Bainier is a polyphyletic assemblage of anamorphic fungi with perfect states in *Byssochlamys*, *Talaromyces*, *Thermoascus*, *Torrubiella* and *Cordyceps*. They are common soil fungi and several species are entomogenous. Samson (1974) divided the genus into two sections and placed *P. javanicus* together with the entomogenous species with *Torrubiella* and *Cordyceps* perfect states in the section Isarioidea. *Paecilomyces* species are frequently characterised by long slender flask-shaped phialides borne on conidiophores (Samson 1974). However in several species the conidiophore is absent, resulting in the production of *Acremonium* or *Cephalosporium*-like solitary phialides (Onions & Barron, 1967). Some species of *Paecilomyces* previously obtained from invertebrates, such as *P. odonateae* Zuo Y. Liu, Z.Q. Liang & A.Y. Liu and *P. loushanensis* Z.Q. Liang & A.Y. Liu are reported to have some monophialidic structures (Liu et al. 1995, Liang et al. 1997).

The closest match for the ITS sequence was *P. javanicus*, although *P. antarcticus* differs from this and other *Cordyceps* associated species in being entirely monophialidic. The morphology does not closely match any of the monophialidic species described by Onions and Barron (1967) as the phialides are generally longer than in these species, and the conidia are distinctly bacilliform. These features are very similar to the species *P. bacillisporus* Onions & G.L. Barron, a species transferred to *Acremonium* by Gams (1971) although again phialides and conidia are larger than described for this species. The colonial morphology is also similar, but colony morphology is not a reliable diagnostic character in this group as several species have similar features, and the colonial morphology can be very dependant on age and growth medium used.

Species of *Paecilomyces* are generally classified as mesophilic to thermophilic, but isolates have been reported to grow at reduced temperatures, and have been isolated from wintering insect larvae (ARSEF, 2004). In the current study the fungus grew out from and colonised the body of the insect at 4°C, but growth at 17°C was faster than at 4°C. Conversely, growth could not be initiated at above 20°C and it would therefore seem likely that this species is psychrophilic rather than psychrotolerant (Kirk et al. 2001).

In general, *Cordyceps* species are host specific, this specificity ranging from a single host species, to a particular group of insects (Nikoh & Fukatsu, 2000; Samson et al., 1988). It has been suggested that this host specificity can be affected by “host-jumping”, whereby a *Cordyceps* species specific to one organism may colonise a different taxon under certain environmental conditions (Niko & Fukatsu, 2000). If this process does occur in *Cordyceps*, the association between the springtail and the *Paecilomyces* anamorph could be due to either a long established co-evolution, or an opportunistic host shift. We are only aware of one previous report of *Paecilomyces* species on a springtail (ARSEF, 2004), and this was identified as *Paecilomyces farinosus*, a relatively common soil species that has also been reported from Antarctic soil and moss (Del Frate & Caretta 1990, Tosi et al. 2002). The exact role of the springtail fungus in the Antarctic is unclear. The collection described here was found from only one of 12 morbid individuals at mid-summer. A subsequent survey of morbid individuals in early autumn recovered the fungus from approximately 1 in 4 individuals (work in progress). This situation could arise if the fungus was a true pathogen, where its presence in the population would be expected to increase as the insect population increased. However it is also possible that the fungus is an opportunistic organism that is better able to colonise older, possibly stressed, individuals. Detailed pathogenicity tests and field collections will be required to elucidate this.

In view of the unique morphology, habitat, host and rDNA sequences the fungus is described as the new species *Paecilomyces anatarcticus*. Antarctic invertebrates have been studied for many years, and although there are many anecdotal reports of mycelial growth on them, there are no reports of recognisable fruiting bodies on cadavers (P. Convey, pers. comm.). The molecular analysis suggests that if a teleomorph is produced it is likely to belong in the genus *Cordyceps*, although the size of the host and the extreme environment may prevent the production of fruiting bodies.

Acknowledgment

The authors thank Dr. Chris Prior and Prof. Yi-Jian Yao for their manuscript presubmission review.

Literature cited

- Altschul SF, Madden TL, Schaffer AA, Zhang J, Zhang Z, Miller W, Lipman DJ. 1997. Gapped BLAST and PSI-BLAST: a new generation of protein database search programs. *Nucleic Acids Research* 25, 3389-402.
- ARSEF. 2004. Current catalog. <http://www.ppru.cornell.edu/mycology/catalogs/Catalog.pdf>
- Balazy S. 1993. *Entomophthorales*. Fungi (Mycota) Flora of Poland Volume 24. Polish Academy of Sciences: Warsaw.
- Bridge PD, Worland MR. 2004. First report of an entomophthoralean fungus on an arthropod host in Antarctica. *Polar Biology* 27: 190-192
- Broza M, Pereira RM, Stimac JL. 2001. The non-susceptibility of soil Collembola to insect pathogens and their potential as scavengers of microbial pesticides. *Pedobiologia* 45: 523-534.
- Del Frate G, Caretta G. 1990. Fungi isolated from Antarctic material. *Polar Biology* 11: 1-7.
- Drechsler C. 1944. A species of *Arthrobotrys* that captures springtails. *Mycologia* 36: 382-399.
- Dromph KM. 2001. Dispersal of entomopathogenic hyphomycete fungi by collembolans. *Soil Biology and Biochemistry* 33: 2047-2051.
- Dromph KM, Eilenberg J, Esbjerg P. 2001. Natural occurrence of entomophthoralean fungi pathogenic to collembolans. *Journal of Invertebrate Pathology* 78: 226-231.
- Dromph KM, Vestergaard S. 2002. Pathogenicity and attractiveness of entomopathogenic hyphomycete fungi to collembolans. *Applied Soil Ecology* 21: 197-210.
- Felsenstein J. 1989. PHYLIP - Phylogeny Inference Package (Version 3.2). *Cladistics* 5: 164-166.
- Gams W. 1971. *Cephalosporium*-artige Schimmelpilze (Stuttgart): 72
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for Basidiomycetes. Application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2: 113-118.
- Göttlich E, de Hoog GS, Genilloud O, Jones BE, Marinelli F. 2003. MICROMAT: Culturable fungal diversity in microbial mats of Antarctic lakes. In: Huiskes AHL, Gieskes WWC, Rozema J, Schorno RML, van der Vies SM, Wolff WJ. (Eds.). *Antarctic Biology in a Global Context*, pp. 251-254. Backhuys Publishers:Leiden.
- Hughes KA, Lawley B. 2003. A novel Antarctic microbial endolithic community within gypsum crusts. *Environmental Microbiology* 5: 555-565.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. *Ainsworth and Bisby's Dictionary of the Fungi*, 9th Edition. CABI Publishing, Wallingford
- Liang ZQ, Liu AY, Huang JZ, Jiao YC. 1997. The genus *Cordyceps* and its allies from Kuankuoshui Preserve in Guizhou II. *Mycosystema* 16: 61-67.
- Liu Z-Y, Liang Z-Q, Liu A. -Y. 1995. A new species of *Paecilomyces* isolated from *Cordyceps odonatae*. *Mycosystema* 8-9: 83-87.
- Nikoh N, Fukatsu T. 2000. Interkingdom host jumping underground: phylogenetic analysis of entomoparasitic fungi of the genus *Cordyceps*. *Molecular Biology and Evolution* 17: 629-638.
- Onions AHS, Barron GL. 1967. Monophialidic species of *Paecilomyces*. *Mycological Papers* 107. CMI: Kew

- Onofri S, Tosi S. 1992. *Arthrobotrys ferox* sp. nov. a springtail-capturing hyphomycete from continental Antarctica. *Mycotaxon* 44: 445-451.
- Pearson WR. 1990. Rapid and Sensitive Sequence Comparison with FASTP and FASTA Methods in *Enzymology* 183: 63-98.
- Peterson SW. 2000. Phylogenetic analysis of *Penicillium* species based on ITS and LSU-rDNA nucleotide sequences. In Samson RA, Pitt JI. (Eds.) *Integration of Modern Taxonomic Methods for Penicillium and Aspergillus classification* p.163-178. Harwood Academic Publishers, The Netherlands.
- Roddam LF, Rath AC. 1997. Isolation and characterization of *Metarhizium anisopliae* and *Beauveria bassiana* from subantarctic Macquarie Island. *Journal of Invertebrate Pathology* 69: 285-288.
- Samson RA. 1974. *Paecilomyces* and some allied hyphomycetes. *Studies in Mycology* 6. CBS: Baarn.
- Samson RA, Evans HE, Latgé JP. 1988. *Atlas of entomopathogenic fungi*. Springer-Verlag: Berlin.
- Sitch JC, Jackson CW. 1997. Pre-penetration events affecting host specificity of *Verticillium lecanii*. *Mycological Research* 101: 535-541.
- Steenberg T, Eilenberg J, Bresciani J. 1996. First record of a *Neozygites* species (Zygomycetes: *Entomophthorales*) infecting springtails (Insecta: Collembola). *Journal of Invertebrate Pathology* 68: 97-100.
- Thompson JD, Higgins DG, Gibson TJ. 1994. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research* 22: 4673-4680.
- Tosi S, Casado B, Gerdol R, Caretta G. 2002. Fungi isolated from Antarctic mosses. *Polar Biology* 25: 262-268.
- van Hanne E, Mooij W, van Agterveld MP, Gons HJ, Laanbroek HJ. 1999. Detritus-dependent development of the microbial community in an experimental system: qualitative analysis by denaturing gradient gel electrophoresis. *Applied and Environmental Microbiology* 65: 2478-2484.
- Vasiliauskas R, Lygis V, Thor M, Stenlid J. 2004. Impact of biological (Rotstop) and chemical (urea) treatments on fungal community structure in freshly cut *Picea abies* stumps *Biological Control* 31 (in press)
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In Innis MA, Gelfand DH, Sninsky JJ, White TJ. (Eds), *PCR protocols: a guide to methods and applications*, p. 315-322. Academic press, San Diego.
- Yokoyama E, Yamagishi K, Hara A. 2002. Group-I intron containing a putative homing endonuclease gene in the small subunit ribosomal DNA of *Beauveria bassiana* IFO 31676. *Molecular Biology and Evolution* 19: 2022-2025.
- Yokoyama E, Yamagishi K, Hara A. 2003. Structures of the mating-type loci of *Cordyceps takaomontana*. *Applied and Environmental Microbiology* 69: 5019-5022.
- Yokoyama E, Yamagishi K, Hara A. 2004. Development of a PCR-based mating-type assay for *Clavicipitaceae*. *FEMS Microbiology Letters* 237: 205-212.
- Zhao J, Wang N, Chen YQ, Li TH, Qu LH. 1999. Molecular identification for the asexual stage of *Cordyceps sinensis*. *Zhongshan Da Xue Xue Bao Zi Ran Ke Xue Ban* 38: 121-123.

Notes on Discomycetes (*Helotiales*, *Pezizales*): New species and new records from Cameroon

Clovis Douanla-Meli & Ewald Langer

cmeli@yahoo.com

Universität Kassel, FB 18 Naturwissenschaften, Institut für Biologie,
FG Ökologie, Heinrich-Plett-Straße 40, D-34132 Kassel, Germany

Abstract — Eight species of Discomycetes in the orders *Helotiales* and *Pezizales* are reported from Mbalmayo rain forest reserve in southern Cameroon. Families represented include the *Geoglossaceae* (*Trichoglossum hirsutum*), *Otideaceae* (*Scutellinia colensoi* and *S. scutellata*), *Sarcoscyphaceae* (*Cookeina colensoi*, *C. insititia*, *C. speciosa* and *C. tricholoma*), *Sarcosomataceae* (*Galiella celebica*). All species except *C. speciosa* and *C. tricholoma* are reported from Cameroon for the first time. Two new species *C. globosa* and *Microstoma camerunensis* are proposed. Descriptions, illustrations and discussions are provided.

Key words — Ascomycetes, apothecium, taxonomy, tropical Africa

Introduction

There is a paucity of information on the Discomycetes of Cameroon. We owe the earlier records from Hennings (1897, 1901). He described three species from south Cameroon, all of which he considered new to science, belonging to order *Pezizales*. Later, Berthet & Boidin (1966) studying the collections from Douala and surrounding area, published summarised notes on Hymenomycetes of Cameroon, including six species of Discomycetes viz. *C. speciosa* (Fr.) Dennis [= *C. sulcipes* (Berk.) Kuntze], *C. tricholoma* (Mont.) Kuntze, *Phillipsia domingensis* (Berk.) Berk., *Lambertella* sp., *Trichoglossum* sp. and *Helotium crocatum* (Mont.) Le Gal. The two orders *Helotiales* and *Pezizales* are common and widespread in Cameroon, as our collections well attest. On the other hand, the genus *Cookeina* Kuntze is also dominant and to date five of the eight *Cookeina* species described are found in Cameroon.

The genus *Cookeina* is thought to be thoroughly studied and its delimitation is relatively well known (Wang 1997; Weinstein et al. 2002; Meléndez-Howell et al. 2003). Weinstein et al. (2002), who recognised seven species in his phylogenetic study, cited no African collections in his world monograph of this genus, however. The above work showed that the broad spectrum of apothecium colours in some taxa (e.g. *C. speciosa* and *C. tricholoma*) does not match anatomical differences. Subsequently, the taxonomy of *Cookeina* is practically based upon the occurrence of hairs on exterior of apothecium, and microscopic features like the ascospore size, shape and ornamentation. The genus *Microstoma* Bernstein, sister to *Cookeina* (Korf 1972; Weinstein et al. 2002), differs in having always hairy apothecia with a gelatinous layer within the ectal excipulum, and

conical apiculate ascospores. It currently accommodates five taxa, hitherto not known in Cameroon.

In the ethnomycological view, two species of Discomycetes *C. speciosa* and *C. tricholoma* are considered edible in the southern Cameroon by the Bagyeli (pygmies) and Bantu (Van Djik et al. 2003). In the Mbalmayo rain forest reserve (MFR), their consumption is restricted particularly to old women. This work addresses the taxonomic study of Discomycetes in the MFR, based on sixteen collections from three forays on the site over the past three years. We cite six new records for Cameroon and describe two species new to science, *C. globosa* and *M. camerunensis*.

Materials and Methods

Sampling was carried out from 2001 to 2003 in the MFR (Douanla-Meli and Langer 2003). Descriptive terminology follows Hanlin (1998). Dried material was sectioned by hand, rehydrated in 5% KOH, and stained with 1% phloxine, Cotton blue or Melzer's reagent. Observation was made using an Olympus BX51TF microscope. Line drawings were made using a grid as drawing aid representing a magnitude of $\times 2000$. Specimens were photographed with a Nikon COOLPIX 4500 Digital, and processed in Photoshop (Adobe Photoshop 4.0). E value is the length divided by the width of the ascospore and Q value is the mean of E of $N = 30$ ascospores. Color terms in parentheses are as described in Kornerup & Wanscher (1978). Herbaria are abbreviated according to Holmgren et al. (1990). The species mentioned are arranged alphabetically. New records for Cameroon are marked with an asterisk (*). Voucher specimens are deposited in Herbarium of Laboratory of Cryptogamy, University of Yaounde I (HUYI), Cameroon.

Taxonomic Descriptions

Cookeina colensoi* (Berk.) Seaver in Mycologia 5(4): 191, 1913. **FIGURE 1e

Apothecia cupulate to shallow, 10-20 mm diameter, substipitate to stipitate, glabrous, brownish yellow (5C8) to brownish orange (6C8); gelatinous layer present. Ectal excipulum of textura angularis, up to 60 μm thick, outer cells globose, 10-40 μm diameter. Medullary excipulum of textura intricata, up to 98 μm thick. Subhymenium of textura intricata. Paraphyses branched, apparently net-like. Asci 310-345 $\times$ 18-20 μm . Ascospores 28-34 $\times$ 11-15 μm , narrowly ellipsoid, smooth, thin-walled, with one or two unequal large oil droplets.

SPECIMENS EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Ekombitie, on dead wood, 16.V.2001, leg. C. Douanla-Meli, DMC 508-HUYI; 16.IX.2002, leg. C. Douanla-Meli, DMC 512-HUYI.

Notes — The species is easily recognised by its glabrous apothecia. It is in that similar to *C. venezuelae* (Berk. & M.A. Curtis) Le Gal, both species also have excipular gelatinous layer, but the latter differs with ornamentation of ascospores. The ellipsoid ascospores differentiate *C. colensoi* from *C. insititia* (Berk. & M.A. Curtis) Kuntze. It is not common in the MFR.

Cookeina globosa* Douanla-Meli sp. nov.*FIGURES 1 a-d & 2**

Ab C. colensoi apotheciis margin pilosis, ascosporis subglobosis vel globosis, (11-)12-15(-16) x (9-)10-12 μ m differt.

Etymology — Latinised form of globose, referring to the subglobose to globose ascospores.

Brief summary — Apothecia stipitate, cupulate, pink to pale red when fresh, turning brownish yellow on dry, up to 20 mm in diameter, fertile surface smooth, sterile surface finely velvety. Ectal excipulum of textura angularis to globulosa, bearing large globose thick-walled cells, medullary excipulum of textura intricata to porrecta, paraphyses branched to net-like, asci 300-370 x (13.5-)17-20 μ m, thick-walled, 8-spored, suboperculate, IKI-, ascospores (11-)12-15(-16) x (9-)10-12 μ m, globose to subglobose, smooth and thin-walled.

Expanded description — **Apothecia** gregarious on the substrate, subsessile to shortly stipitate, deeply cupulate, disc pink (11A5) to pale red (10A3) on fresh and brownish yellow (5C8) on dry, 8-20 mm diameter and 4-12 mm deep. Fertile surface smooth, shiny, lower sterile surface glabrous to finely velvety. Margin entire, erect but slightly incurved when dry, fringed with short white hairs of up to 1 mm long. **Stalk** when distinct cylindrical, often curved, up to 3-5 mm long, pale orange (5A3), of textura porrecta, hyphae of up to 5 μ m diameter, hyaline, simple septate, nearly thick-walled. **Ectal excipulum** 60-100 μ m thick, of textura angularis to globulosa, composed of a few layers of polygonal cells in gelatinous tissues, the outer cells globose, larger with thickened yellowish brown (5E8) walls, inner cells hyaline. **Medullary excipulum** of textura intricata to porrecta, composed of hyaline, loosely interwoven hyphae, up to 6 μ m diameter. **Subhymenium** of textura intricata, well distinguishable from medullary excipulum, 10-25 μ m thick. **Hymenium layer** 320-400 μ m thick, easily separate from excipular layer, composed of asci and paraphyses. **Paraphyses** branched and connected as a net, 1-4 μ m diameter, slightly enlarged at apices, equal to asci in length, hymenial hairs scarce, protruding up to 45 μ m above the asci level. **Asci** 300-370 x (13.5-)17-20 μ m, unitunicate but thick-walled, cylindrical, slightly tapering at the base and usually contracted into a short narrow stalk, uniseriate, 8-spored, suboperculate with operculum arranged obliquely on ascus apex, apex IKI-. **Ascospores** (11-)12-15(-16) x (9-)10-12 μ m, E = 1-1.4, Q = 1.3, all maturing simultaneously, subglobose to globose, thin-walled, smooth, usually filled with two large and several small oil droplets.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Oyack II, on dead twigs and wood, 20.IX.2002, leg. C. Douanla-Meli, **HOLOTYPE** DMC 542-HUYI.

Notes — The members of the genus *Cookeina* growing on dead branches and wood in moist tropical areas are typically recognizable by their brightly colored and cupulate apothecia (Hanlin 1998; Weinstein et al. 2002). This genus shares in the family *Sarcoscyphaceae* many features with *Sarcoscypha* (Fr.) Boud., *Phillipsia* Berk. and *Microstoma*, such as simultaneous maturation of ascospores and anastomosing paraphyses. Several studies attempted to resolve its taxonomic delimitation (Korf 1972; Le Gal 1953; Pfister 1973). In recent studies focusing on this genus based on phylogeny and ultrastructure (Weinstein et al. 2002; Meléndez-Howell et al. 2003), the findings

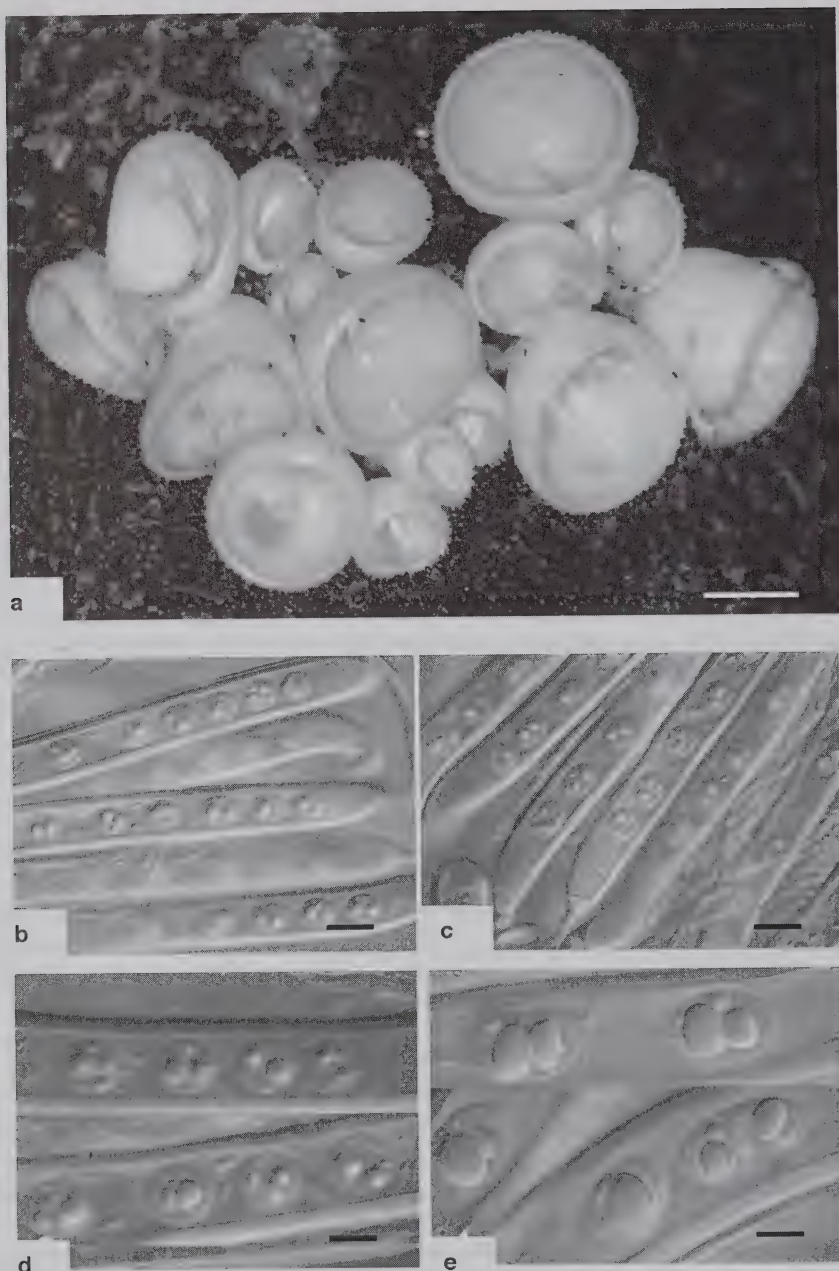


Figure 1 — **a.** Apothecia of *Cookeina globosa* (Holotype DMC 542) on dead wood. **b-e.** Micrographs of asci with ascospores in light microscope. **b-d.** *Cookeina globosa* (Holotype DMC 542). **e.** *Cookeina colensoi* (DMC 508). Scale bar = 1 cm for a; 15 μm for b-c and 10 μm for d-e.

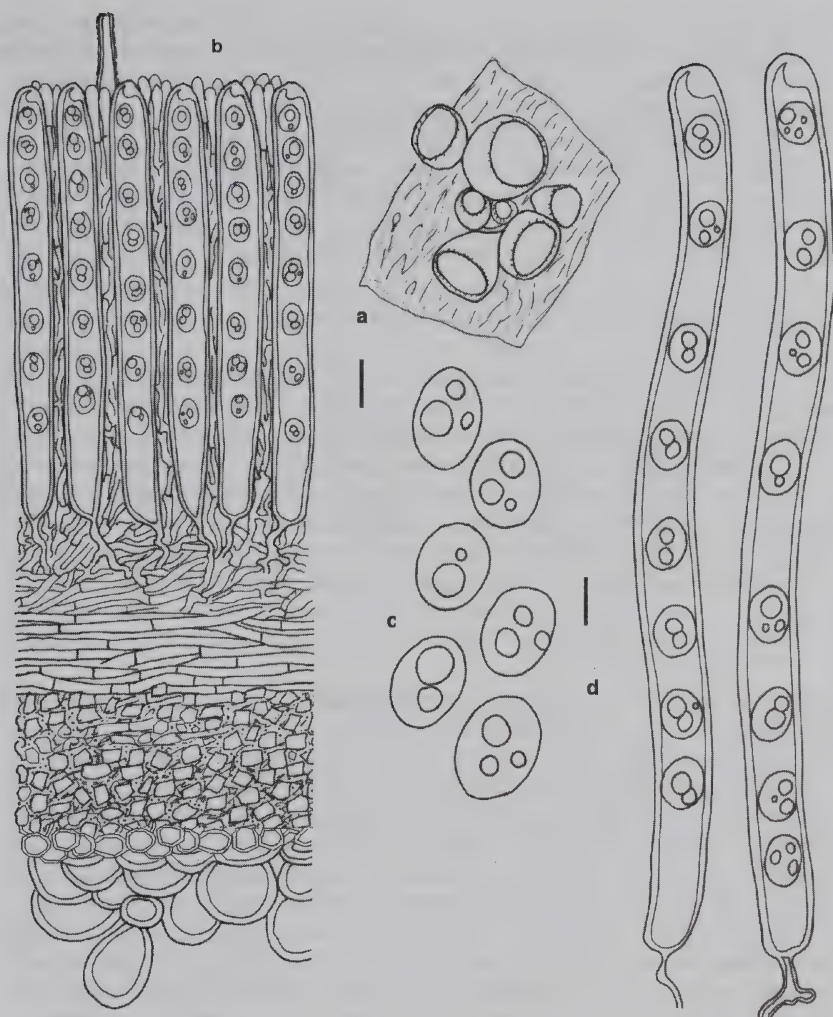


Figure 2 — *Cookeina globosa* (Holotype DMC 542). **a.** Apothecia on dead wood. **b.** Section through portion of ectal, medullary excipulum and hymenium with asci and connected paraphyses. **c.** Mature ascospores. **d.** Asci with ascospores. Scale bar = 1 cm for a; 10 μ m for c and 20 μ m for d.

enabled a better understanding and separation of different morphospecies within the genus. The new species herein described is characterized in having cupulate and smooth apothecia, gelatinous layer present in ectal excipulum, suboperculate asci, ascospores smooth, subglobose to globose. These features support its placement in *Cookeina*. With reference only to the gross morphology, this species resembles *C. venezuelae* and *C. colensoi*. The former species is held apart on the base of its unique ascospores ornamentation consisting of longitudinal ribs with fine transverse interconnecting

ridges. Whereas the apothecia of the latter are also sessile but may be long-stipitate, stalk up to 3 cm long in collection of MFR, mostly scattered on substrate, and totally smooth lacking marginal fringes. The ascospores of *C. globosa* are smooth and thin-walled; this character is shared with *C. insititia*, *C. sinensis* and *C. colensoi* (Weinstein et al. 2002). The two former species are clearly different with their fusoid and subfusoid to lemon-shape ascospores respectively, and prominent hairs clothing the apothecia. Whereas *C. colensoi* can also be easily distinguished from the longer, subfusoid to ellipsoid ascospores, 28-34 x 11-15 μm , with two to three large oil droplets. All other species of *Cookeina* differ by the differently shaped ascospores.

**Cookeina insititia* (Berk. & M. A. Curtis) Kuntze in Rev. gen. pl. (Leipzig) 2: 849, 1891.

Apothecia cup-shaped to discoid, stipitate, up to 12 mm diameter, pink (12A4), stalk 2-20 mm long, white hairs surrounding the margin, arising from outer layer. Ectal excipulum up to 95 μm thick, of textura globulosa to angularis, with inner gelatinous layer, outer cells hyaline, up to 31 μm diameter. Medullary excipulum of textura intricata, up to 200 μm thick; subhymenium of textura intricata. Paraphyses branched, net-like, with broad apices, equal to asci in length. Asci 390-435 x 14-20 μm . Ascospores (40-)43-52 x 8-11 μm , fusoid, thin-walled, apparently smooth in light microscope.

SPECIMENS EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Oyack II, on dead wood, 20.IX.2002, leg. C. Douanla-Meli, DMC 511-HUYI; on dead wood, 17.V.2001, leg. C. Douanla-Meli, DMC 506-HUYI.

Notes — *C. colensoi* and *C. sinensis* are closely related to *C. insititia* in having smooth ascospores. However, *C. insititia* is different in fusoid instead of ellipsoid or lemon-shape ascospores (Wang 1997). It is also easily separate with stipitate hirsute apothecia, a gelatinous layer and the enormous size of ascospores. The taxonomic status of *C. insititia* has been the most discussed within the genus *Cookeina* (Ito and Imai 1937; Korf 1972; Weinstein et al. 2002, Meléndez-Howell et al. 2003). The phylogenetic analysis (Weinstein et al. 2002) failed to confirm its relationship with other species of *Cookeina* and Meléndez-Howell et al. (2003) suggested its placement in the subgenus *Boedijnopeziza* [as *B. insititia* (Berk. & M.A. Curtis) S. Ito & S. Imai] on the account of ultrastructural dissimilarities with other species of *Cookeina*, but accessing its definitive resolution requires more investigations. In the MFR, this species is not common as *C. speciosa*.

Cookeina speciosa (Fr.) Dennis in Mycotaxon 51: 239, 1994.
= *C. sulcipes* (Berk.) Kuntze in Rev. Gen. Pl. 2: 849, 1891.

Apothecia funnel-shape, 8-20 mm diameter, stalk 10-40 mm long, hairs short, up to 2 mm forming rings toward the margin. Hymenial surface smooth, yellow orange (4A8), grayish brown (6E3) to pale chocolate brown (6F4), highly hygrophanous, becoming upon drying uniformly concolored, pastel yellow (2A4) to brownish yellow (5C8), outer surface paler than the hymenium. Hairs composed of bundles of septate and thick-walled hyphae. Ectal excipulum of textura angularis, outer cells globose, with thickened hyaline to light brown (6D8) walls. Medullary excipulum of textura intricata. Subhymenium of textura intricata. Paraphyses branched and net-like, exceeding the asci

level. Asci 300-370 x 17-19 μm . Ascospores (22-)24-33 x (10-)12-16 μm , ellipsoid, thick-walled, surface with longitudinal ridges, biguttulate, at times with a large and a small oil droplets.

SPECIMENS EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Ekombitie, 18.IX.2002, on dead wood, leg. C. Douanla-Meli, DMC 510-HUYI; 16.X.2002, 17.V.2001, on rotten wood, leg. C. Douanla-Meli, DMC 507-HUYI; 16.V.2001, on dead wood, leg. C. Douanla-Meli, DMC 505-HUYI; Oyack II, 15.IV.2001, on rotten wood, leg. C. Douanla-Meli, DMC 501-HUYI.

Notes — Specimens of MFR have a broad spectrum of apothecial colours from orange-yellow, orange to chocolate brown on fresh, and almost undistinguishable on dried, however without anatomical microscopic differences (Weinstein et al. 2002). No relevant relationship could be noted between the habitat luminosity and the apothecial pigmentation. The taxonomic treatment of this complex species is not completely resolved. Weinstein et al. (2002) believed that at least two taxa are hidden within *C. speciosa* complex. The striking distinctive features are the sinusoid ornamentation of ascospores walls (Meléndez-Howell et al. 2003) and the lack of gelatinous layer. *C. tricholoma*, the much related species differs in having evenly distributed hairs arising from medullar excipulum (Wang 1997) and *C. sinensis* equally with hirsute apothecia differs in its smooth-walled ascospores. *C. speciosa* is widespread in Cameroon, previously recorded from Douala and Japoma (Berthet & Boidin 1966), common in the MFR.

Cookeina tricholoma (Mont.) Kuntze in Revis. gen. pl. (Leipzig) 2: 849, 1891.

FIGURE 3

Apothecia deeply cup-shaped to funnel-shaped, gregarious, 6-14 mm diameter, pale (2A2) to greyish beige (4C2) clothed with long prominent, up to 5 mm long, whitish hairs, sparse but more close around the margin, extended up to the stalk. Hairs composed of an aggregation of elongate cells, thick-walled, arising from medullar excipulum. Ectal excipulum 35-60 μm thick, of textura angularis, cells up to 20 μm diameter, medullary excipulum of textura intricata, up to 250 μm thick; subhymenium of textura intricata. Paraphyses much branched, net-like. Asci 290-345 x 12-17 μm . Ascospores (18.5-)20-33 x (8.5-)11-15 μm , pointed-ellipsoid, surface with fine longitudinal ridges, thick-walled, biguttulate or with several small oil droplets.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Ekombitie, on rotten wood, 17.IX.2002, leg. C. Douanla-Meli, DMC 504-HUYI.

Notes — This species is closest to *C. sinensis*, with the colour range and hairs of apothecia. Weinstein et al. (2002) showed *C. tricholoma* phylogenetically sister to *C. sinensis*, in the other hand misidentification is possible as the smooth ascospores of *C. sinensis* may represent immature ascospores of *C. tricholoma*. *C. speciosa* is different by the hairs arising from ectal excipulum instead from medullar excipulum (Wang 1997) and paraphyses exceeding asci. The mature ascospores of Cameroon collection are distinctly striate. *C. tricholoma* was previously reported from Douala (Berthet & Boidin 1966), but it is apparently not common as *C. speciosa*.

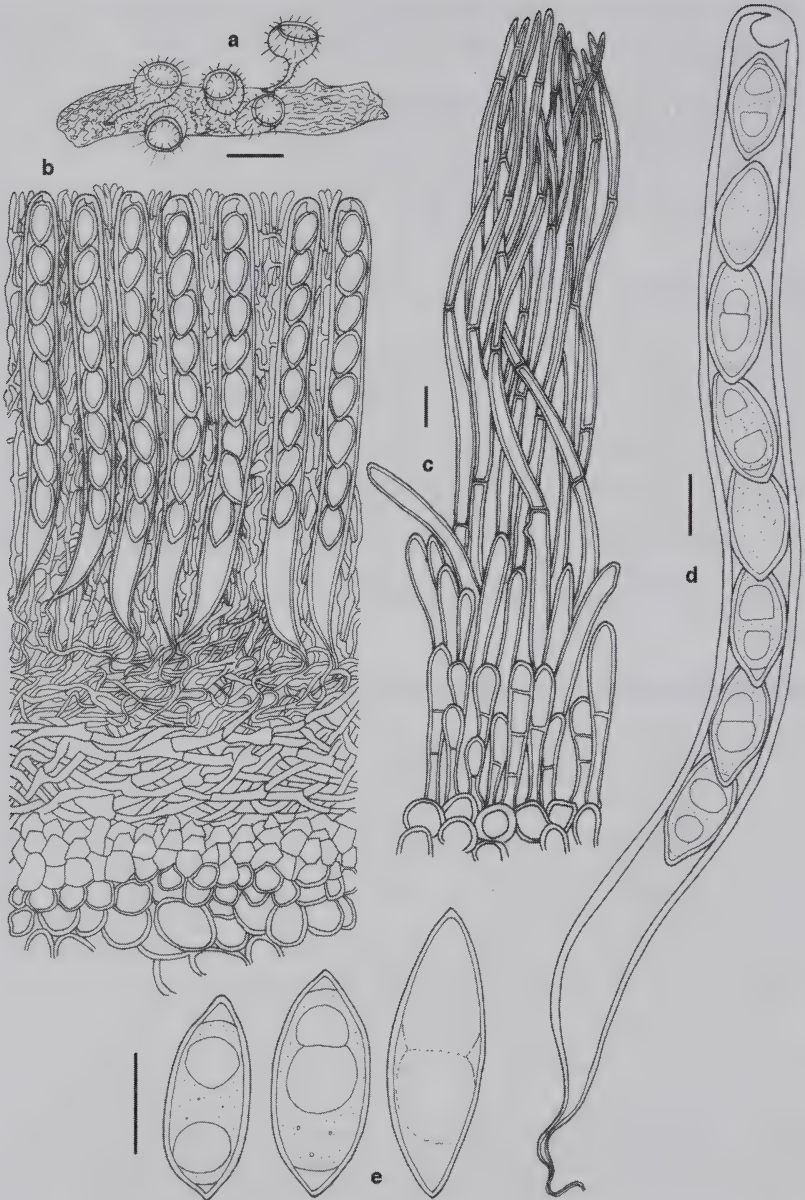


Figure 3 — *Cookeina tricholoma* (DMC 504). **a.** Apothecia growing on wood, with long stalk and deeply cup-shaped disc externally hairy. **b.** Section through portion of ectal, medullary excipulum and hymenium with asci and net-like paraphyses. **c.** Apothecial hairs composed of bundles of septate and thick-walled hyphae. **d.** Mature ascus with ascospores. **e.** Mature ascospores with acute ends. Scale bar = 1 cm for a; 50 μ m for c; 15 μ m for d-e.

**Galiella celebica* (Henn.) Nannf., in Korf, Mycologia 49: 108, 1957

FIGURE 4

Apothecia seated on short stalk, closed up to slightly urn-like, 3-4 cm diameter; fertile surface pale yellow (2A4), fringed towards the margin with conspicuous hairs, yellowish pale (2A3) to light brown (6D8), septate, 7-16 μm broad, slightly thick-walled and smooth; sterile surface dark gray (-F1), translucent, bearing fine hairs rooted in the outermost cells layer, septate, yellowish pale (2A3) to brownish gray (6E2), often minutely asperulate or smooth; flesh rubbery to gelatinous becoming hard on dry. Ectal excipulum thin, of textura angularis composed of 2-3 layers of angular cells. Medullary excipulum of textura intricata. Paraphyses filiform, enlarged at the apex, 3-6 μm diameter. Asci 350-370 x 10-20 μm . Ascospores 22-37(-41) x 12-18 μm , ellipsoid, with narrow ends, thick-walled, with 2-3 large and connected oil droplets, surface minutely tuberculate.

SPECIMEN EXAMINED — CAMEROON, CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Ekombitie, 10.V.2001, on decaying hardwood, leg. C. Douanla-Meli, DMC 543-HUYI.

Notes — The species of *Galiella* are characterised by the gelatinous excipular tissues of apothecia. The ascospore size and features of hairs clothing the apothecia vary among species and are diagnostic specific features. *G. rufa* has hairy outer wall, with fertile surface reddish brown and smooth, smaller ascospores 20 x 10 μm (Kuo 2002). *G. javanica* with ascospores of 25-37 x 10.5-15 μm resembles *G. celebica*, but differs by the warted dark brown and thick-walled hairs (Zhuang & Wang 1998). The Cameroon collection fits the description of Chinese collection (Zhuang & Wang 1998), which in turn is close to the original description by Hennings (1900), however, differs in the minutely asperulate to smooth hymenial hairs. The minutely warted ascospores known in this species (Pant 2001) can be discerned under the light microscope. *G. celebica* is not common in MFR.

Microstoma camerunensis Douanla-Meli nov. sp.

FIGURES 5-6

Ab Microstoma floccosum, ascosporis fusiformae vel ellipsoidae, (13-)14-16(-17) x 3-4(-4.5) μm , extremae ambae apiculatae differt; ab Microstoma apiculosporum apiculatae conicus 2-4 x 1-2.5 μm differt.

Etymology — Latinised form of Cameroon, referring to the country of type specimens

Brief summary — Apothecia stipitate, cupulate, 4-18 mm in diameter, upper surface yellowish white to brownish grey, clothed with whitish hairs, margin fringed with raised hairs, articulate, thick-walled, ectal excipulum of textura angularis to globulosa, medullary excipulum of textura porrecta in a dense gelatinous layer, paraphyses connected, asci 245-335 x (6-)7-12 μm , 8-spored, suboperculate, thin-walled. Ascospores (13-)14-16(-17) x 3-4(-4.5) μm , ellipsoid to fusiform, thin-walled, smooth, apiculate at both ends, apiculi conical, 2-4 x 1-2.5 μm .

Expanded description — **Apothecia** scattered to gregarious, stipitate, cup-shaped with raised margin at first becoming slightly convex at maturity, 4-18 mm diameter; stalk 9-20 mm long, round to flattened. Hymenial surface pinkish (11A4), smooth,

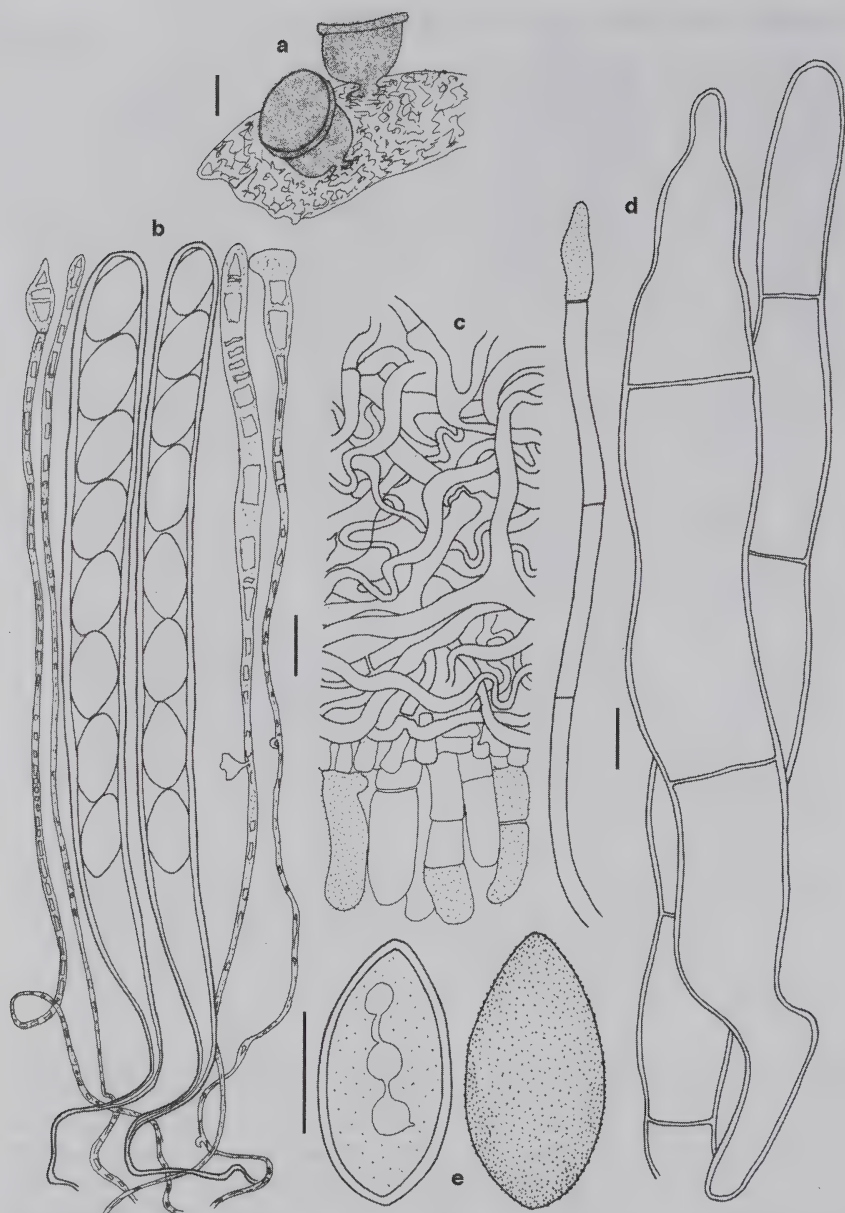


Figure 4 — *Galiella celebica* (DMC 543). **a.** Apothecia on wood, cup-shaped with short stalk. **b.** Asci with ascospores and paraphyses. **c.** Section through ectal excipulum showing hymenial hairs. **d.** Marginal hairs, septate with smooth and slightly thickened walls. **e.** Mature ascospores with connected oil droplets and minutely tuberculate surface. Scale bar = 1.5 cm for a; 30 μ m for b; 10 μ m for d and 15 μ m for e.

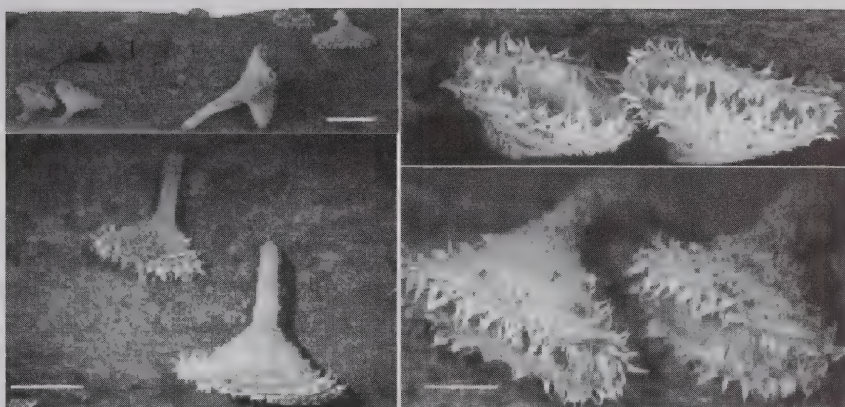


Figure 5 — *Microstoma camerunensis* (Holotype DMC 509). Apothecia scattered on dead wood, with bunch of hairs surrounding the margin. Scale bar = 1 cm.

shiny, turning brownish yellow (5C8) on dried. Exterior of receptacle yellowish white (2A2) to brownish grey (6E2) with whitish hairs of uneven length, concentrically arranged, moderately hairy downwards to the stalk; margin fringed with multiples raised hairs, arising from ectal excipulum, simple, setose, tapering to a point, up to 1.5 mm long, composed of articulate cells, easily detachable, variable in shape, $5\text{--}100 \times 3\text{--}27 \mu\text{m}$, hyaline, thick-walled. **Ectal excipulum** of textura angularis to globulosa, composed of large angular, globose and elongate cells, with slightly thickened walls. **Medullary excipulum** in gelatinous tissues, of textura porrecta. **Subhymenium** of textura intricata, composed of thin- to slightly thick-walled, hyaline hyphae, strongly interwoven. Hymenium composed of ascus and paraphyses. **Paraphyses** branched, connected as a net, with subclavate apices, slightly projecting beyond the asci level. **Asci** $245\text{--}335 \times (6\text{--})7\text{--}12 \mu\text{m}$, 8-spored, suboperculate, thin-walled, cylindrical, tapering towards the base to a flexuous stalk with thickened walls in the subhymenium, apex IKI–. **Ascospores** $(13\text{--})14\text{--}16\text{--}(17) \times 3\text{--}4\text{--}(4.5) \mu\text{m}$, narrow ellipsoid to fusiform, thin-walled, smooth, apiculate at both ends, apiculi conical, $2\text{--}4 \times 1\text{--}2.5 \mu\text{m}$.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, $11^{\circ} 54' \text{ E}$, $3^{\circ} 58' \text{ N}$, 500–650 m asl., Oyack II, on dead wood, 18.IX.2002, leg. C. Douanla-Meli, **HOLOTYPE** DMC 509-HUYI.

Notes — The species of *Microstoma* are characterised and easily recognized in the field by the dense white hairs over a scarlet cup. The new species is macroscopically characterised by the conspicuous white hairs clothing the apothecia, the pinkish colour, and microscopically by the presence of thick gelatinous layer within the ectal excipulum, ascospores smooth and thin-walled, smaller sized, with conical apiculi. Other members of the genus like *M. floccosum* (Schein.) Raitv., *M. aggregatum* Y. Otani, *M. protractum* (Fr.) Bernstein and *M. macrosporum* (Y. Otani) Y. Harada & S. Kudo are microscopically distinguished by the broader size of ascospores, which are almost without apiculi. The brown subiculum characteristic of *M. floccosum* (Wang 2001) is lacking in *M. camerunensis*. *M. apiculosporum* Y. Z. Wang the closest

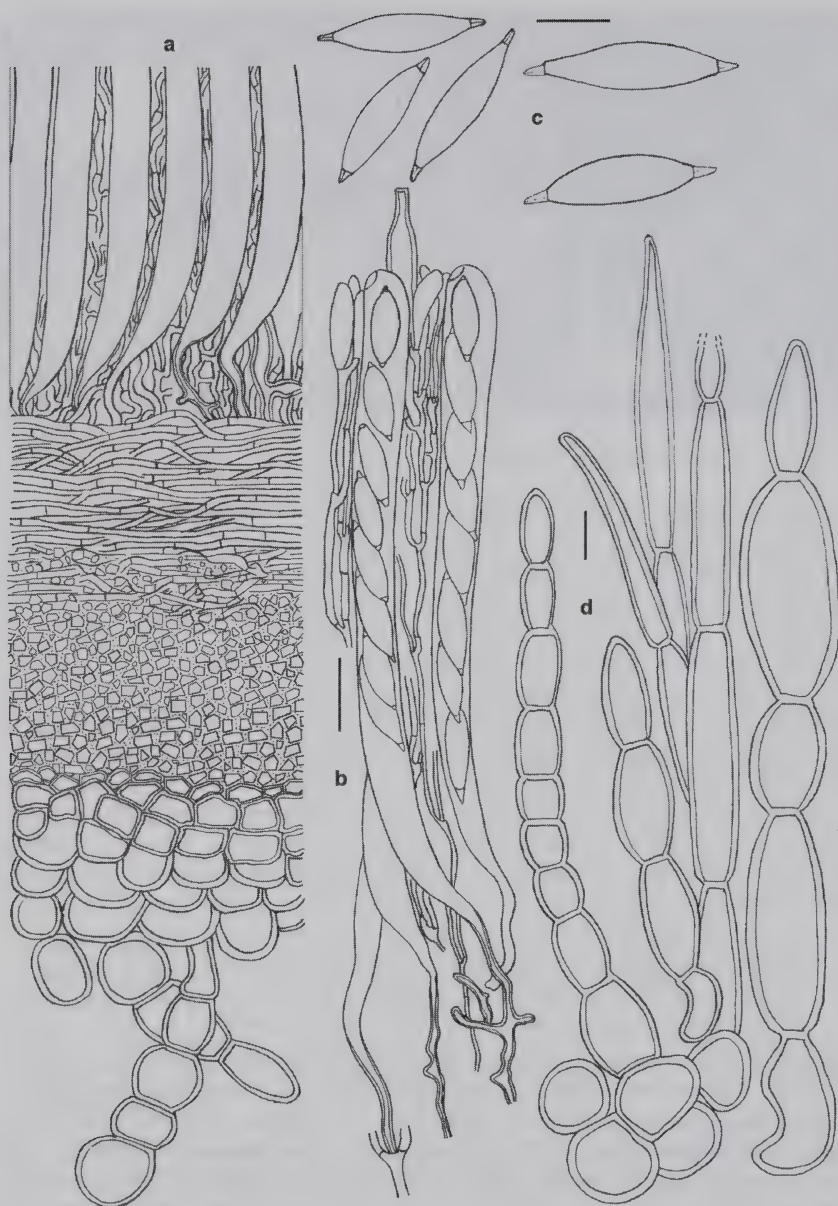


Figure 6 — *Microstoma camerunensis* (Holotype DMC 509). **a.** Section through portion of ectal, medullary excipulum and hymenium with asci and connected paraphyses. **b.** Asci with ascospores. **c.** Mature ascospores showing conical apiculi. **d.** Apothecial hairs composed of short and elongate articulate elements. Scale bar = 30 μm for a and b; 10 μm for c and d.

species with ascospores apiculate at both ends, is however easily separate in having broader ascospores $25\text{--}30 \times 9\text{--}10 \mu\text{m}$, with hemispherical apiculi instead of conical. *M. camerunensis* differs also from the five *Microstoma* species currently recognised by its articulate apothecial hairs, with articles easily disconnected.

**Scutellinia scutellata* (L.) Lambotte in Mém. Soc. roy. Sci. Liège, série 2 1: 299, 1887.

Apothecia plane dish- to disk-shaped, sessile, 3–6 mm diameter, red (9A8) to orange red (8A8). Margin covered with long, eyelash-like hairs, 1–2 mm long and $22\text{--}37 \mu\text{m}$ diameter, with simple or bifurcate base, 1–4 septate, thick-walled, dark brown (6F7–6F8) to dark (5E4). Ectal excipulum of textura angularis, composed of large angular to elongate cells, up to $60 \mu\text{m}$ in diameter. Medullary excipulum of textura intricata. Paraphyses moniliform, marginally exceeding the asci level. Asci $210\text{--}270 \times 11\text{--}14 \mu\text{m}$. Ascospores $(13\text{--})18.5\text{--}21 \times 10\text{--}12 \mu\text{m}$, with slightly thickened walls, ellipsoid to narrowly fusoid, with two large and several small oil droplets, surface covered with distinctive pits and craters in face view, bumpy, short warts visible in profile.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, $11^\circ 54' \text{E}$, $3^\circ 58' \text{N}$, 500–650 m asl., Ekombitie, on dead wood, 09.X.2002, leg. C. Douanla-Meli, DMC 503-HUYI.

Notes — The closest species is *S. barlae* (Boud.) Maire similar with discoid red apothecia, eyelash-like marginal hairs bifurcate at base, but differs in having globose ascospores, $17\text{--}23 \mu\text{m}$ diameter.

**Scutellinia colensoi* Massee ex Le Gal in Bull. trimest. Soc. mycol. Fr. 83(2): 356, 1967.

Apothecia discoid, sessile, 3–8 mm diameter, orange (6A8). Marginal hairs $200\text{--}1650 \times 15\text{--}45 \mu\text{m}$, simple or bi- to trifurcate at base, 1–3 septate, and thick-walled, dark brown (6F7–6F8); superficial hairs present, thin-walled or slightly thick-walled $80\text{--}170 \times 5\text{--}20 \mu\text{m}$, septate. Ectal excipulum of textura angularis, up to $250 \mu\text{m}$ thick. Medullary excipulum of textura intricata, up to $300 \mu\text{m}$ thick. Paraphyses moniliform, often branched near the base and swollen at apices. Asci $175\text{--}215 \times 11\text{--}15 \mu\text{m}$. Ascospores $(13.5\text{--})15\text{--}20 \times (7.5\text{--})10\text{--}12 \mu\text{m}$, ellipsoid, one or biguttulate, surface with distinct pits and craters in face view, bumpy and short warts visible in profile.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, $11^\circ 54' \text{E}$, $3^\circ 58' \text{N}$, 500–650 m asl., Oyack II, on dead trunk of *Elaeis guineensis*, 18.IX.2002, leg. C. Douanla-Meli, DMC 502-HUYI.

Notes — The species is presumably the most distributed (Schumacher 1990). It is recognised by the orange coloured apothecia with long marginal hairs. Cameroon collection is closest to Chinese material (Zhuang & Wang 1998), which differs a little from the typical material.

**Trichoglossum hirsutum* (Pers.) Boud. in Histoire et Classification des Discomycètes d'Europe (Paris) 1: 86, 1907.

Apothecia clavate, up to 7 cm tall, the fertile part spoon-shape, spade-shaped, flattened, often grooved, up to 2 cm long and 0.5–1 cm wide, covered with stiff black

hairs; stalk round, 1-2.5 mm diameter, equal, black (5E4), conspicuously pubescent. Hairs setae-like, dark brown (6F8) to dark grey (-F1), 85-400 x 9-15 μm , with acute to pointed end. Paraphyses branched downwards, septate, enlarged at apices, 5-9 μm diameter, apical cell almost curved. Asci 8-spored, 160-250 x 22-24 μm , IKI +. Ascospores 130-150 x 5-6 μm , filiform and tapering at each end, with 15 to 16 septa, light brown (6D8), pale yellow (2A3) to olive yellowish (3D7).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, in the MFR, 11° 54' E, 3° 58' N, 500-650 m asl., Oyack II, scattered on ground, 20.IX.2002, leg. C. Douanla-Meli, DMC 538-HUYI.

Notes — The species is easily recognised by the apothecia wholly clothed of velvety hairs. Species of *Geoglossum* have similar appearance, and differ only with smooth surface. Cameroon collection has larger apothecia like those of *T. hirsutum* var. *latisporum* W. Y. Zhuang, and its ascospores with 15-16 septa differs only in less broader size. Some old Cameroonian specimens of *Trichoglossum* described by Berthet & Boidin (1966) in juvenile stadium lacked developed ascospores for enabling specific determination, thus this species is herein considered new to Cameroon.

Acknowledgments

The authors are indebted to Prof. Calonge and Prof. Bellemère for critically reviewing the early manuscript. We wish to thank Mr. Robert Zambo for facilitating fieldwork. Thanks are directed to Dr. LL Norvell, Pacific Northwest Mycology Service (USA), for editorial assistance. Financial assistance provided by the German Academic Exchange Service (DAAD) grant A/01/20502 to the senior author is gratefully acknowledged.

Literature Cited

- Berthet P, Boidin J. 1966. Observations sur quelques Hyménomycètes récoltés en République Camerounaise. Cah. Maboké 4: 27-54.
- Douanla-Meli C, Langer E. 2003. A new species of *Lignosus* (*Polyporaceae*) from Cameroon. Mycotaxon 84: 389-394.
- Hennings P. 1897. Fungi camerunensis I. Bot. Jahrb. Syst. 23: 537-558.
- Hennings P. 1900. Fungi. Mosunia 1: 1-38.
- Hennings P. 1901. Fungi camerunensis III. Bot. Jahrb. Syst. 30: 39-57.
- Hanlin RT. 1998. Combined keys to illustrated genera of Ascomycetes Volumes I & II. The American Phytopathological Society. 107 pp.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum: Part I: Herbaria of the World. 86th ed. Bronx, New York Botanical Garden.
- Ito S, Imai S. 1937. Fungi of the Bonin Islands II. Trans Sapporo Nat. Hist. Soc. 15: 52-59.
- Korf RP. 1972. A synoptic key to the genera of the *Pezizales*. Mycologia 64: 937-994.
- Kornerup A, Wanscher JH. 1978. Taschenlexikon der Farben, 1400 Farbnuancen und 600 Farbnamen. Musterschmidt-verlag. Zürich-Göttingen. 242 pp.
- Kuo M. 2002. *Galiella rufa*. Retrieved from the MUSHROOMEXPERT.COM Web site: http://www.bluewillowpages.com/mushroomexpert/galiella_rufa.html
- Le Gal M. 1953. Les Discomycètes de Madagascar. Prodr. Flore Mycol. Madagascar 4: 1-465.
- Meléndez-Howell LM, Mascarell G, Bellemère A. 2003. Etudes ultrastructurales dans le genre *Cookeina* (Ascomycetes, *Pezizales*, *Sarcoscyphaceae*). Mycotaxon 87: 53-80.
- Pant DC. 2001. *Galiella celebica* from India. Mycotaxon 79: 315-318.

- Pfister DH. 1973. Notes on Caribbean discomycetes IV. *Cookeina venezuelae*, *C. colensoi* and the genus *Boedijnopeziza*. Phytologia 27: 55-62.
- Schumacher T. 1990. The genus *Scutellinia*. Opera Bot. 102: 1-107.
- Van Dijk H, Onguene NA, Kuyper TW. 2003. Knowledge and utilization of edible mushrooms by the local populations of the rain forest of south Cameroon. Ambio 32: 19-23.
- Wang Y-Z. 2001. Discomycetes of the *Sarcoscyphaceae* in Taiwan. Mycotaxon 79: 329-336.
- Wang Y-Z. 2004. A new species of *Microstoma* from Taiwan. Mycotaxon 89(1): 119-122.
- Wang Z. 1997. Taxonomy of *Cookeina* in China. Mycotaxon 62: 289-298.
- Weinstein RN, Pfister DH, Iturriaga T. 2002. A phylogenetic study of the genus *Cookeina*. Mycologia 94(4): 673-682.
- Zhuang W-Y, Wang Z. 1998. Some new species and new records of Discomycetes in China. VIII. Mycotaxon 66: 429-438.
- Zhuang W-Y, Wang Z. 1998. Sarcosomataceous discomycetes in China. Mycotaxon 67: 355-364.

Myxomycetes of Mezit Stream Valley of TurkeyC. CEM ERGÜL¹, BAŞARAN DÜLGER² & HASAN AKGÜL¹*ergulc@uludag.edu.tr*¹*Uludag University, Faculty of Arts and Sciences
16059, BURSA-TURKEY*²*Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences
17100, ÇANAKKALE- TURKEY*

Abstract—The myxomycete diversity of the Mezit valley and vicinity was assessed from 1999 to 2002 in the Southern Marmara region of the Bursa and Eskişehir provinces of Turkey. Of the 36 species and 12 genera listed, 22 represent new records for the valley and surroundings. The ecology of the valley is briefly discussed. A map of the study area and the checklist are available at the website http://biyoloji.uludag.edu.tr/ergul/Checklist_001.pdf.

Key words—slime moulds, taxonomy, Mediterranean

Introduction

Approximately 200 species of true myxomycetes have been recorded previously for Turkey (Lohwag 1957, 1964; Sümer 1982; Harkönen & Uotila 1983; Harkönen 1987; Ergül & Dülger 2000, 2002; Ocak & Hasenekoğlu 2003a, b). The present study was carried out in the Mezit stream valley, which is located in the Marmara region of the Western Anatolia (Bursa and-Eskişehir provinces). This climate of this region in the south Marmara part of Turkey is distinguished from the rest of the Marmara and central Anatolian regions. The Mezit valley region (40°02' N, 29°38' E; elevation 410–650 m) has a cool, humid to subhumid, eastern to central Mediterranean climate with annual temperature averaging 12.0–12.3° C and rainfall ranging between 436 and 568 mm. Macroclimatic features of the region were obtained from the meteorology stations in the cities Bilecik and İnegöl, which are situated near the study area (Anonymous 1995). These data suggest that the Mezit valley region is highly similar to eastern Mediterranean and partially to central Mediterranean regions with respect to seasonal rainfall (Akman 1990). The Mezit stream runs through the entire region with several sharp turns along with Bursa-Eskişehir road. The valley is up to 30 m deep with convex slopes averaging 30°. The high humidity that results from the narrow valley base and tall, dominant trees such as *Fagus orientalis*, *Platanus orientalis* and *Carpinus betulus* form a temperate forest that is conducive to the development of myxomycetes. The vegetation of the Mezit stream valley and Mezit stream itself provide very specific microenvironmental conditions in the study area. High and sustained humidity, optimum

temperature, canopy, rich forest accumulation, and slow microbial turn over form local microclimatic conditions that provide optimum conditions for the development of certain species of Myxomycetes (Ing 1994). Trunks, twigs, stems, leaf litter and the other organic debris that are present in microsites in the valley are sufficient for the development of myxomycetes. In a previous study we identified 13 different taxa from this region and neighboring localities that were new records for Turkey (Ergül & Dülger 2002). In this study, we have identified 23 different taxa from the Mezit valley, bringing the total number of myxomycetes found in the valley to 36 species representing 12 genera.

Material and Methods

Samples were collected from the Mezit bridge series of Bursa-Eskişehir highway during 1999-2002, viz Mezit 3-4, Mezit 4-5, Mezit 7-8 (40°02' N, 29°38' E), elevation 410, 440, and 650 m respectively. Field studies were conducted during early and late summer. Mature sporangia of myxomycetes were collected directly from substrata (forest floor debris, logs, twigs, decaying wood, dead standing trunks and driftwood) on several collecting trips.

Microscopic observations were made on material mounted in Hoyer's medium. Taxonomic characterizations of samples were done using basic data obtained from macro- and microscopical investigations of the specimens.

Identifications were made using several keys (Martin & Alexopoulos 1969, Farr 1976, Nannenga-Bremekamp 1991, Ing 1999). We followed the nomenclature of Lado (2001).

For each taxon we provide information on distribution, collection sites, date and herbarium number. A map of the study area and the checklist are available at the website http://biyoloji.uludag.edu.tr/ergul/Checklist_001.pdf.

All of the specimens are deposited in the Uludag University Herbarium (BULU) and in the personal collection of Cem Ergül (C.E.).

Discussion

Northwestern Turkey, which is located in the Mediterranean zone, has four distinct seasons and is vegetationally diverse. These features provide enormous advantages for studying the taxonomy and ecology of myxomycetes. Nonetheless, macroclimatic and topographically harsh conditions make field studies rather difficult. Hence, field studies have been carried out only during seasons when the weather has been favorable, which vary from region to region.

The present research was undertaken in an area dominated mainly by Mediterranean climate. The study area shows the so-called Marmara transition climate that is located between the eastern Marmara and central Anatolia climates (Akman 1990, Erinc 1996). The Eastern Marmara region is located in the thermic climate group and it becomes similar to the mezothermic region during the hot summer season (Akman 1990). However, local climatic conditions in this valley make this study region rather cool and highly favorable for the development of myxomycetes, even during the hot summer days. Periodical influences of extreme macroclimatic conditions such as periods of

heavy and/or long rain and/or snowfall, high or low temperature are effective biotic factors of the microenvironment. According to Lado et.al. (1999), seasonality of the rain could be the other major reason for the difference in their reproductive phenology. In addition, Lado (1993) concludes, "There are two peaks in the sporulation phenology of myxomycetes in the Mediterranean zone, one spring and another in the late autumn". Mezit stream and its vicinity are affected by summer rains. It also has high relative humidity due to the closed valley and forest vegetation that cover it. The dominant biotic factors resulting from canopy and stream effects are unique to the research area and isolate this microenvironment from the regional climate.

Most myxomycetes were found between the Mezit 7 and Mezit 8 bridges. The other productive localities between Mezit 3 and Mezit 5. A total of 62 samples, which belong to 12 genera and 36 species, were collected directly from these four localities. Except for the *Echinosteliales*, all orders of myxomycetes were present in the studied region. We think that *Echinosteliales* order could be detected with moist chamber technique. This approach could increase the number of myxomycetes species of the region but we did not use moist chamber technique in the study. The *Trichiales* was the best represented order with 15 species, followed by the *Stemonitales* (9 species). The remaining species belonged to the *Ceratiomyxales*, *Liceales* and *Physarales*.

Arcyria cinerea, the most frequently found taxon, was identified five times in the region; *Lycogala epidendrum* and *Trichia botrytis* each appeared four times. The other taxa are less frequent. The main reason for the high number of lignicolous species could be the abundance of excellent, slowly rotting substrata such as fallen trunks, twigs, soggy timbers and decaying wood. The most abundant species were in *Arcyria* and *Stemonitis* (each with 8 species). *Trichia*, *Cribraria*, *Physarum*, *Fuligo* and *Lycogala* followed with a decreasing number of species. *Famintzinia*, *Craterium*, *Metatrichia*, *Hemitrichia* and *Stemonitopsis* genera were represented with only one species each. Lignicolous species of the region are *Stemonitis* spp., *Cribraria* spp., *Trichia* spp., *Lycogala* spp., *Fuligo* spp., *Famintzinia fruticulosa*, *Hemitrichia calyculata*, *Metatrichia vesparium* and *Stemonitopsis typhina*. Follicolous species were represented by *Physarum* and *Craterium* taxa. *Stemonitopsis typhina* and *Trichia varia* were present in all localities of the study area. Most of the lignicolous species and some of the corticolous and a few follicolous species that were identified in our studies were discovered in localities near the humid stream base and valley slopes. *Arcyria affinis* and *A. cinerea* have an affinity for corticolous and lignicolous substrata. Whereas, *Craterium minutum* and *Physarum flavicomum*, *P. nutans*, *P. viride* are found only on follicolous substrata. The other taxa are primarily lignicolous. Despite the presence of abundant leaf litter in the valley, the number of follicolous species was considerably lower than expected. The reasons for this bias might be the nonrandom and limited selection of the study periods, localities and substrata.

Acknowledgements

We wish to express our thankfulness to Dr. Gary J. Samuels, USD, ARS, Beltsville and Dr. Martin Schnittler EMAU Greifswald Bot. Inst., for critical reading of the manuscript.

References

- Akman Y. 1990. İklim ve Biyoiklim, Palme Yayın Dağıtım: Ankara (Turkey). 320pp.
- Anon. 1995. Meteorological Bulletin, Devlet Meteoroloji İşleri Genel Müdürlüğü: Ankara (Turkey). 675pp.
- Ergül CC, Dülger B. 2000. Myxomycetes of Turkey. *Karstenia* 40: 39–41. Botanical Congress 201-206.
- Ergül CC, Dülger B. 2002. New Records for the Myxomycetes Flora of Turkey. *Tr. J. of Botany*. 26: 277–280.
- Eriñç S. 1996. Klimatoloji ve Metodları. Alfa Basım Yayım Dağıtım: İstanbul (Turkey). 538 pp.
- Farr ML. 1976. Flora Neotropica, Monograph No 16, Myxomycetes. The New York Botanical Garden: New York (USA). 305 pp.
- Härkönen M., Uotila P. 1983. Turkish Myxomycetes developed in moist chamber cultures. *Karstenia* 23: 1–9.
- Härkönen M. 1988. Some addition to the knowledge of Turkish Myxomycetes. *Karstenia* 27: 1–7.
- Ing B. 1994. The Phytosociology of Myxomycetes. *New Phytol.* 126: 175-201.
- Ing B.1999. The Myxomycetes of Britain and Ireland. The Richmond Publishing Co. Ltd. (England). 374 pp.
- Lado C. 1993. Myxomycetes of Mediterranean woodlands. In:Pegler D.N, Boddy L., Ing B., Kırk P.M.(eds.):Fungi of Europe: Investigation, recording and conservation. Royal Botanical Garden: Kew (England). 93-114.
- Lado C, Rodriguez-Palma, Estrada-Torres. 1999. Myxomycetes from a Seasonal Tropical Forest on the pacific coast of Mexico. *Mycotaxon* LXXI: 307-321.
- Lado C. 2001. Caudernos De Trabaja De Flora Micologica Iberica, 16, Nomenmyx. Consejo Superior De Investigaciones Cientificas Real Jardin Botanico: Madrid (Spain). 219 pp.
- Lohwag K. 1957. Türkiye'nin Mantar Florası hakkında araştırma. *I.Ü.O.F. Der. Ser. A.7(1)*: 129–137.
- Lohwag K. 1964. Belgrad Ormanından mikolojik notlar. *I.Ü.O.F. Der. Ser. A.14 (2)*: 128–135.
- Martin GW, Alexopoulos CJ. 1969. The Myxomycetes. University of Iowa Press: Iowa (USA). 561 pp.
- Nannenga-Bremekamp NE. 1991. A Guide to Temperate Myxomycetes. Biopress Ltd.: Bristol (England). 409 pp.
- Ocak İ, Hasenekoğlu İ. 2003a. Myxomycetes from Erzurum, Bayburt and Gümüşhane Provinces,Turkey. *Tr. J. of Botany* 27: 223–226.
- Ocak İ, Hasenekoğlu İ. 2003b. Four New Records of Myxomycetes from Turkey. *Tr. J. of Botany* 27: 333-337.
- Sümer S.1982. Batı Karadeniz bölgesi, özellikle Bolu çevresinde bulunan odun tahripçisi mantarlar. *İ.Ü.O.F. Yayınları*. 321: 1–94.

A new species of *Dacryopinax* from Mexico

SIGFRIDO SIERRA AND JOAQUÍN CIFUENTES

ssg@hp.fciencias.unam.mx

Sección de Micología, Herbario FCME

Fac. de Ciencias, UNAM

A.P. 70-181 Coyoacán, C.P. 04510

México, D.F.

Abstract—*Dacryopinax lowyi* is described as new. The species can be differentiated from others in the genus by basidiome characteristics, a zone of subcortical vesicles and vesicular hyphae, basidiospores and basidia features, and substrate preference. A key to all known species of *Dacryopinax* is also provided.

Key words—*Dacrymycetales*, Neotropics, biological diversity, taxonomy

Introduction

According to Ainsworth & Bisby's Dictionary of the Fungi (Kirk *et al.* 2001) the genus *Dacryopinax* G.W.Martin includes 10 species worldwide. Since the original description by Martin in 1948, McNabb (1965) treated seven species, while Lowy (1971) included six species from the Neotropics. Altogether these two studies covered eight different species. Descriptions of seven new species have been published (Lowy 1981, 1987; Zang 1985; Lowy & Cortecuisse 1991; Liu *et al.* 1988; Liu & Fan 1990), and to date a total of fifteen different species have been recognized:

Dacryopinax aurantiaca (Fr.) McNabb, *D. crenata* Lowy, *D. dennisii* McNabb, *D. elegans* (Berk. & M.A. Curtis) G.W. Martin, *D. foliacea* B. Liu & L. Fan, *D. formosus* Lowy & Courtec., *D. indacocheae* Lowy, *D. macrosporus* B. Liu, L. Fan & Y.M. Li, *D. martinii* Lowy, *D. maxidorii* Lowy, *D. petaliformis* (Berk. & M.A. Curtis) McNabb, *D. spathularia* (Schwein.) G.W. Martin, *D. taibashanensis* B. Liu & L. Fan, *D. xizangensis* Lowy & M. Zang and *D. yungensis* Lowy.

Materials and Methods

All specimens were collected and studied using standard mycological techniques (Martin 1952; Lowy 1971; Cifuentes *et al.* 1986; Sierra 1992; Sierra & Cifuentes 1993; Sierra 1995; Sierra 2000). Specimens were prepared for scanning electron microscopy according to the methods described by Bozzola & Russell (1999). Abbreviations of herbarium names are taken from Index Herbariorum (Holmgren & Holmgren 1990). Color numbers are from Methuen Handbook of Colour (Kornerup & Wanscher 1978).

Taxonomy

Our extensive bibliographic review revealed 52 names previously proposed for the fifteen species of *Dacryopinax*, most now regarded as synonyms (8 nomenclatural and 28 taxonomic) for species belonging to other genera. Only one taxonomic synonym was found under *Dacryopinax* (Sierra 2000). Four different species from Mexico were discovered during the authors' taxonomic review of their own collections as well as those housed in five Mexican herbaria (ENCB, FCME, MEXU, TLXM and XAL) and three US herbaria (BPI, LSUM and NY). Three species previously reported for Mexico include *D. elegans*, *D. spathularia* and *D. yunguensis* (García-Romero et al. 1970, Lowy 1965, Lowy 1971, Lowy & Guzmán 1979, Mendiola & Guzmán 1973, Pérez-Silva & Esqueda 1992). The following species is new to science.

***Dacryopinax lowyi* S. Sierra & Cifuentes, sp. nov.**

FIGURES 1-2

Basidiomata pileata-stipitata, spathulata vel cupulata, margine lobulato, in vivis 35 mm alta, gelatinosa-cartilaginea, rubra-aurea vel aurantia-cinerea, sicca cornea. Hymenio unilaterali, cupulam interius, glabro vel papillato. Basidiosporis 13-17 X 4.5-7.5 µm, phaseoliformibus vel lacrimoides, hyalinis vel luteolis, postremo 3-septatis. Hilo ornato, una prominentia tuberculatis. Basidis 40.5-76 (-84) X 3-6 µm. Sterigmatibus 19-35 X 2-4.5 µm. Subabhymenio cellulis 42 X 22.4 µm, vesiculatis catenulatis, pariete incrassato. Abhymenio setis pariete incrassato. Hyphis sine fibulis. Stipite setoso, setis 100 X 5.6 µm, septatis.

Etymology: In memory of the eminent American mycologist Dr. Bernard Lowy, who contributed extensively to the knowledge of the neotropical jelly fungi.

Basidiome (Fig. 1A) pileate-stipitate; pileus orbicular, spathulate to cupulate, margin lobulate in mature specimens; external part of cup or spatula (abhymenium) with hairs (pilose); hymenium smooth to papillate; stipe eccentric, cylindrical, pilose. When fresh, total height of basidiome 35 mm; consistency gelatinous-cartilaginous; pileus 2-35 mm diameter; when young, specimens golden-red (6C7) to orange-gray (6B4) maturing yellow-apricot (5B6), sienna (6D7), brick red (7D6), discoloring with age to orange-brown (7C5); stipe 2-25 mm height, 3-10 mm broad; orange-white (5A4). When dried horny, total height then to 25 mm; pileus 2-22 mm diameter; hymenium liver-brown (8F6) to rusty brown (8F7); abhymenium brown-bronzed (7E5) to titian red (7D6); stipe 2-20 mm height, 1-1.5 mm broad; reddish blonde (5C4) to orange-gray (5B3).

Hymenium unilateral in the internal part of cup-shaped basidiomes or on one side of spathulate-shaped basidiomes. Spores (Fig. 1C-E, 2C, 2D) 13-17 X 4.5-7.5 µm, ellipsoid, oblong to obovoid, some lacrymoid to phaseoliform, hyaline to yellowish, guttulate, smooth, non-septate (Fig. 1C, 2C) when immature, becoming 3-septate (Fig. 1D, 2D); germinating by germ tube or producing subspherical conidia (Fig. 1E, 2F) 1.5-3 X 1.5-2.25 µm, hilar appendix provided with one tubercle (Fig. 2C, 2D). Probasidia (Fig. 1B) 40-77 (-82.5) X 2.5-4.5 µm, cylindrical to calvate, hyaline, guttulate. Basidia (Fig. 1B) 40.5-76 (-84) X 3-6 µm, bifurcate. Sterigmata (Fig. 1B, 2A, 2B, 2E) 19-35 X 2-4.5 µm, cylindrical, hyaline, apex attenuate. Subcortical zone with globose, thick-walled elliptical to obovoid, subglobose or irregular vesicles, these borne singly and laterally on hyphae, or sometimes catenate (Fig. 1F), yellowish, to 42 X 22.4 µm.

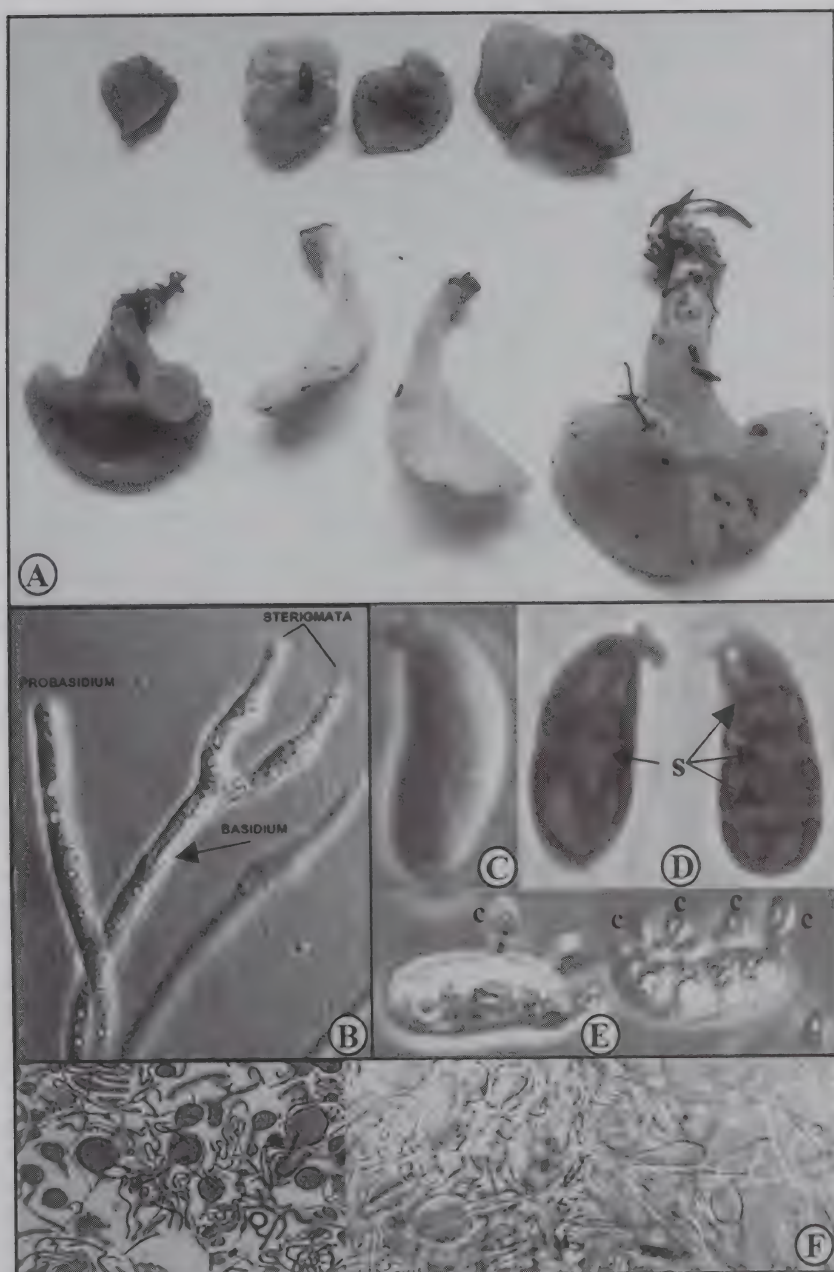


Figure 1: A. Basidiome. B. Probasidium, Basidium and Sterigmata. C-E. Spores: C. non septate, D. 1-3 septate (s), E. producing subspherical conidia (c). F. Sub-abhymenium hyphae.

Abhymenium with long, cylindrical, thick-walled hairs, to $100 \times 5.6 \mu\text{m}$, hyaline-yellowish. All hyphae clampless. Stipe hairs yellowish, cylindrical, septate and sparsely forked.

Ecology, Range, and Distribution: Lignicolous. On wood of *Juniperus* and other conifers. Known only from Neovolcanic Axis, in *Abies*, *Abies-Pinus* and *Juniperus* forest from July to September. Gregarious.

HOLOTYPE EXAMINED—MEXICO. MICHOACAN – Municipio de Angangueo ATRÁS DE LA ESTACIÓN DE LA RESERVA ESPECIAL DE LA BIÓSFERA MARIPOSA MONARCA (REBMM) ($100^{\circ}16'W$, $19^{\circ}40'N$) — 21.VII.2000 Ruiz & Sierra 773 (FCME 17489, HOLOTYPE).

OTHER SPECIMENS EXAMINED—MEXICO. DISTRITO FEDERAL – Delgación Tlalpan km 32 Autopista Mexico-Cuernavaca, Cerca Del Límite Con El Estado De Morelos, 21.VII.1968, Gastón Guzmán 6753 (ENCB). **ESTADO DE MÉXICO** – Municipio De Amanalco De Becerra km 39 Carr. Toluca-Amanalco-Valle De Bravo, Poblado De Agua Bendita, 7.VI.1990, Sierra S/N (FCME 3184). Municipio De Amecameca km 14 Carr. Amecameca-Tlaxmacas, 15.VII.1993, Sierra 165 (FCME 20406). Municipio De Jalatlaco km 11 Carr. Jalatlaco-Ajusco, 3.VIII.1988 Pérez-Ramírez 901 (FCME 4562). Municipio De Ocuilán 3 km Al O De Sta. Martha Lagunas De Zempoala, 18.IX.1977 C. Flores S/N (ENCB); Laguna Quila, 26.IX.1996 Sierra 625 (FCME 20407). Municipio De Salazar Cerro Cabezas 9.IX.1962 M. Ruiz-Oronoz S/N (LSUM, 2 later collections with same data). Municipio De Temascaltepec: Desviación A El Polvorín Km 54 Carr. Toluca-Temascaltepec, 23.VII.1988 Pompa-González 44 (FCME 14317); Desviación A La Peñuela Carr. Toluca-Temascaltepec, 23.VII.1982 Gastón Guzmán 21680 (ENCB). MICHOACÁN – Municipio De Angangueo Llano De Las Papas 15.VII.1999 Sierra 728 (FCME 17020); 4.VIII.1999 Sierra 733 (FCME 17014); 15.VII.1999 Sierra 725 (FCME 17025). Llano Villalobos 12.IX.1998 Arias Y Pellicer-González 81 (FCME 15079); 26.IX.1998 Sierra 698 (FCME 15030). Municipio De Ciudad Hidalgo km 186 Carr. Toluca-Morelia, 29.VII.1983 Paez Aguirre S/N (FCME 11569). Municipio De Zinapécuaro Laguna Larga Zona De Protección Forestal Los Azufres, 3.VII.1987 Núñez Mariel S/N (FCME 13863). **MORELOS** – Municipio De Huitzilac Cercanías De La Laguna De Ojotongo Parque Nacional Lagunas De Zempoala, 28.VI.1967 Gastón Guzmán 5728 (ENCB); Al Pie De La Carr., Bosquecillo De Cedros, Tres Marías, 7.VIII.1968 Gastón Guzmán 6901 (ENCB). **TLAXCALA** – Municipio De Tlaxco Parque Recreativo El Rodeo Cerro De El Peñón, 14.VIII.1992 Sierra 96 (FCME 4847).

COMMENTS — This species is easily recognized by the presence of vesicles in the subcortical zone, by the ornamented hilar appendix of basidiospores, and by the spore and basidial size, which are larger than in related species. The closest species is *D. yungensis*, which also has globose catenate hyphal, but differs in smaller spore size (*D. yungensis* $10.6\text{--}13 \mu\text{m}$ and *D. lowyi* $13\text{--}17 \mu\text{m}$), hilar appendix is not ornamented, yellow tones in fresh basidiomata (in *D. yungensis*) and smaller basidial size ($28\text{--}46 \mu\text{m}$ in *D. yungensis* and $40\text{--}77 \mu\text{m}$ in *D. lowyi*). *D. yungensis* has only been found in dicotyledonous forests (Lowy 1959; Pérez-Silva & Esqueda 1992) while *D. lowyi* has only been found in conifer forests (*Abies*, *Pinus* and *Juniperus*). Another closely related species which could be confused is *D. elegans* because its basidiomata have similar colours; but the context thickness (thinner in *D. elegans*), absence of globoid vesicles or catenate cells, and distribution of the known specimens (tropical forest for *D. elegans*)

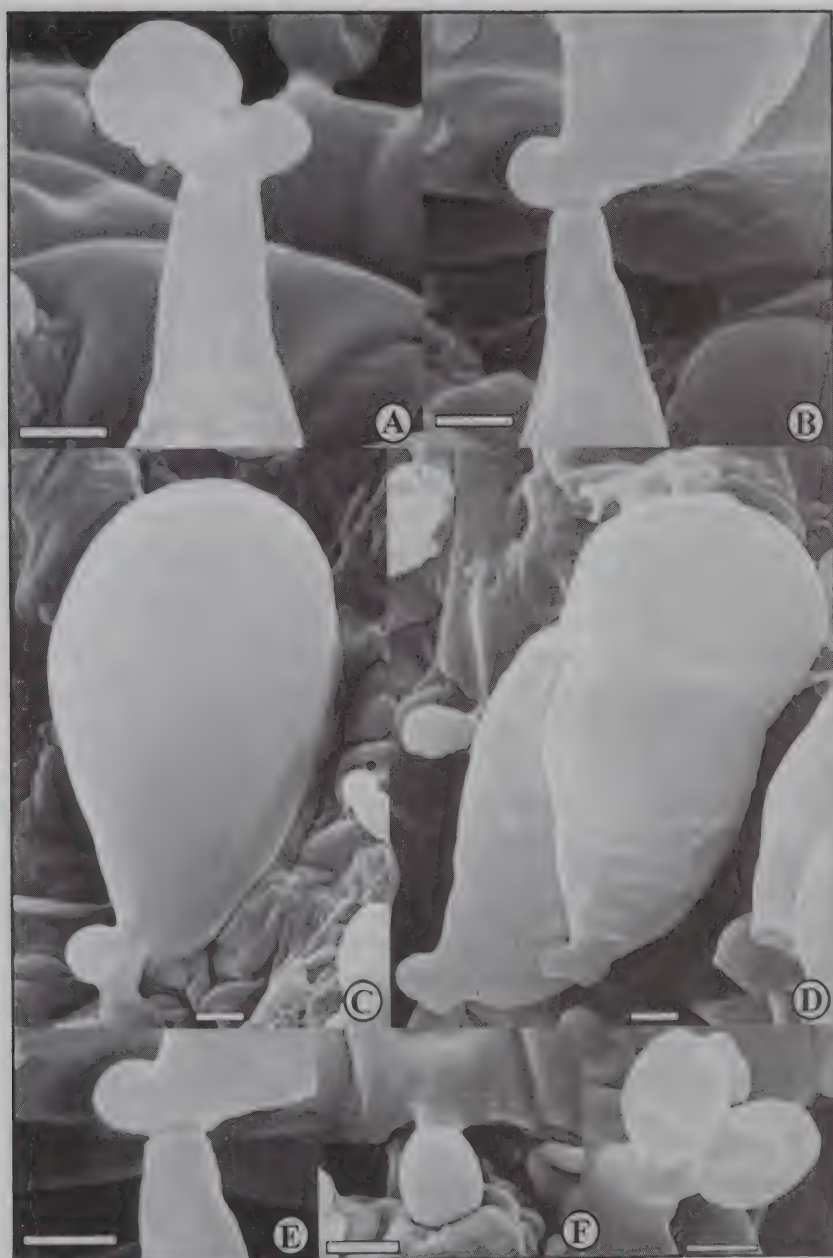


Figure 2: A. Sterigma producing spores. B. Mature spore attached to sterigma. C. Spore non-septate. D. Spore with 1 septa and hilar appendix ornamented. E. Sterigma and hilar appendix ornamented. F. Spores germinating producing subspherical conidia. All scale bar = 1 μm .

allow the two species to be separated. *D. lowyi* was incorrectly considered to be *D. elegans* by Sierra and Cifuentes (1993).

Key to all known species of *Dacryopinax*

- 1a Basidiospores when mature normally with 1-3 septa 2
- 1b Basidiospores when mature normally with 4 or more septa 13
- 2a Inflated vesicles present in subcortical zone 3
- 2b Inflated vesicles absent 6
- 3a Basidiomata when mature normally > 30 mm long, predominantly with reddish brown tones *D. lowyi*
- 3b Basidiomata when mature normally < 20 mm long, predominantly with yellowish brown tones. 4
- 4a Basidiomata foliose with multiple lobes; mature basidiospores 1-septate *D. indacocheae*
- 4b Basidiomata simple, cupulate or obliquely cupulate; mature basidiospores 3-septate 5
- 5a Hymenium with coarse papillae, basidiomata more than 15 mm high *D. yungensis*
- 5b Hymenium smooth, basidiomata less than 15 mm high *D. dennisii*
- 6a Stipe tomentose or not, basidiomata normally > 40 mm long 7
- 6b Stipe always tomentose, basidiomata normally < 40 mm long 8
- 7a Pileus diameter reach 10 mm; stipe and abhymenium not tomentose *D. martinii*
- 7b Pileus diameter reach 50 mm; stipe and abhymenium tomentose ... *D. maxidorii*
- 8a Cells of abhymenial hairs inflated *D. petaliformis*
- 8b Cells of abhymenial hairs cylindrical 9
- 9a Basidiomata with yellow-orange tones 10
- 9b Basidiomata with dark brownish tones 11
- 10a Hyphal pegs present in abhymenium *D. formosus*
- 10b Hyphal pegs absent *D. spathularia*
- 11a Pileus spatulate, margin crenate *D. crenata*
- 11b Pileus spreading-orbiculate, margin undulate 12
- 12a Mature basidiospores predominantly 3 septate *D. elegans*
- 12b Mature basidiospores predominantly 1 septate *D. aurantiaca*
- 13a Basidiospores length > 30 μ m 14
- 13b Basidiospores length < 30 μ m 15
- 14a Mature basidiospores up to 15 septate; hyphae clampless *D. macrospora*
- 14b Mature basidiospores up to 7 septate; hyphae with clamps ... *D. taibashanensis*
- 15a Mature basidiospores commonly muriform *D. xizangensis*
- 15b Mature basidiospores commonly longitudinally septate *D. foliacea*

Taxonomic studies on the *Dacrymycetales* (and on jelly fungi in general) are scarce in tropical areas. Although the genus *Dacryopinax* is one of the better-studied taxa, this study demonstrates species still remain to be described.

Acknowledgements

We wish to thank Dr. Robert J. Bandoni and Dr. Peter Roberts for reviewing the manuscript and for helpful comments; Dr. Juan M. Lopez-Bautista for reviewing the English version, MS. Martha Martinez Gordillo for reviewing the Latin diagnosis. The SEM photographs were made in the Laboratorio de Microscopia de Barrido by MS. Silvia Espinosa Matias and Nomarsky photographs by Biol. Ana Isabel Bieler Antolin and Biol. José Antonio Hernández Gómez of Laboratorio de Microscopia, Facultad de Ciencias, UNAM. This research was supported by DGAPA IN-217198, IN-206901, IN-223704 and CONACYT 29011-N and 34313-V.

Literature Cited

- Bozzola JJ, Russell, L.D. 1999. Electron microscopy. Principles and techniques for biologists. 2nd. edition. Jones & Bartlett. Sudbury, Massachusetts.
- Cifuentes J, Villegas M, Pérez-Ramírez L. 1986. Hongos. In: Lot A. & Chiang F. (Eds.) Manual de Herbario. Cons. Nac. Fl. Méx., A.C. México.
- García-Romero L, Guzmán G, Herrera T. 1970. Especies de macromicetos citadas de México. I. Ascomycetes, *Tremellales* y *Aphylllophorales*. Bol. Soc. Mex. Mic. 4: 54-76.
- Holmgren PK, Holmgren NH. 1990. Index Herbariorum. Part I. The Herbaria of the World. 8th ed. NYBG Press. New York.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed., International Mycological Institute, CAB International, Wallingford.
- Kornerup A., Wanscher JH. 1978. Methuen Handbook of Colour. Eyre Methuen, Londres.
- Liu B., Fan L. 1990. New species and new variety of *Dacrymycetaceae* in China. Acta Mycologica Sinica 9: 12-19.
- Liu B, Fan L, Tao K. 1988. Five new species of *Dacrymycetaceae* from China. Acta Mycologica Sinica 7: 1-6.
- Lowy B. 1959. New or noteworthy *Tremellales* from Bolivia. Mycologia 51: 840-850.
- Lowy B. 1965. Estudio sobre algunos *Tremellales* de México. Bol. Soc. Bot. Mex. 29: 19-33.
- Lowy B. 1971. Flora Neotropica, Monograph No. 6. *Tremellales*. Hafner. Nueva York. 153 pp.
- Lowy B. 1981. A new species of *Dacryopinax* from Brazil. Mycotaxon 13 (2): 428-430.
- Lowy B. 1987. New Brazilian Heterobasidiomycetes. Mycotaxon 29 (1): 11-19.
- Lowy B, Cortecuisse R. 1991. Elements for a Mycological inventory of the Vicinity of "Saut Pararé" (Arataye River) and "Nouragues Inselberg" (French Guiana) III. Heterobasidiomycetideae. Mycotaxon 39: 329-344.
- Lowy B., Guzmán G. 1979. Nuevos registros de *Tremellales* de México. Bol. Soc. Mex. Mic. 13: 211-214.
- Martin GW. 1952. Revision of the North Central *Tremellales*. Verlag Von J. Cramer, Lehre. 122 pp.
- McNabb RFR. 1965. Taxonomic studies in the *Dacrymycetaceae*. III. *Dacryopinax*. N. Z. J. Bot. 3: 59-72.
- Mendiola G, Guzmán G. 1973. Las especies de *Tremellales* conocidas en México. Bol. Soc. Mex. Mic. 7: 89-97.
- Pérez-Silva E, Esqueda M. 1992. First records of jelly fungi (*Dacrymycetaceae*, *Auriculariaceae* and *Tremellaceae*) from Sonora, México. Mycotaxon 44 (2): 475-483.

- Sierra S. 1992. Contribución al estudio taxonómico de algunos hongos tremeloides (Heterobasidiomycetes) del centro y sur de México. Tesis de Licenciatura, Fac. de Ciencias, UNAM. México, D.F.
- Sierra S. 1995. Taxonomía y ultraestructura de algunas especies de la familia *Dacrymycetaceae* en México. Tesis de Maestría (Biología Vegetal), Fac. de Ciencias, UNAM. México D.F.
- Sierra S. 2000. Estudio taxonómico y monográfico del orden *Dacrymycetales* (Fungi) en México. Tesis de Doctorado (Biología), Fac. de Ciencias, UNAM. México D.F.
- Sierra S, Cifuentes J. 1993. Contribución al estudio taxonómico de los hongos tremeloides (Heterobasidiomycetes) de México. *Rev. Mex. Mic.* 9: 119-137.
- Zang M. 1985. Notes on the genus *Dacryopinax* in China. *Mycotaxon* 22 (1): 99-104.

MYCOTAXON

Volume 92, pp. 251-254

April–June 2005

New rust fungi (*Uredinales*) from Mt. Elgon, Uganda

HALVOR B. GJÆRUM

plantevernet@planteforsk.no

Norwegian Crop Research Institute, Høgskoleveien 7
NO-1432 Ås, Norway

MARY NAMAGANDA

mary.namaganda@umb.no

Department of Ecology and Nature Management, Norwegian University of Life
Sciences, Urbygningen, P.O. Box 5003, NO-1432 Ås, Norway

KÅRE ARNSTEIN LYE

kare.lye@umb.no

Department of Ecology and Nature Management, Norwegian University of Life
Sciences, Urbygningen, P.O. Box 5003, NO-1432 Ås, Norway

Abstract – Two rust species, *Aecidium melleræ* on *Mellera lobata* and *A. senecionis-jacksonii* on *Senecio jacksonii*, are described as new to science. One rust species is reported as new to Uganda, viz. *Puccinia isolepidis* on *Isolepis fluitans*, previously known from Ethiopia only. With the new records the rust flora of Mt. Elgon consists of 98 species in 13 genera.

Key words – microfungi, new taxa, parasite

Introduction

Mt. Elgon, one of the largest volcanoes in the world, is about 50 km across with a 5–6 km wide crater. It is situated on the border between Uganda and Kenya between 1° and 2° north. The mountain rises from a relatively flat area at 1100–1300 m to the highest part of the crater rim at 4321 m. The slopes are cultivated and deforested up to about 2000 m, where the National Park starts. The forests consist mainly of mountain bamboo (*Arundinaria alpina*) and *Hagenia–Rapanea* subalpine forests, or in the drier northern parts also of *Juniperus–Podocarpus* forest. Above the timberline at around 3000 m there is a heathland zone dominated by grasses and *Erica* trees or shrubs. Above 3500 m the grasslands are often wetter and boggy with or without scattered *Dendrosenecio*-trees.

The rust fungi of Mt. Elgon are particularly well collected along the mountain track on the western side. We have visited the southern and western side for about 5 weeks, the northern and drier side for about two weeks.

Materials and methods

The identifications presented below are based on material collected by the senior author in October 1970 and by the junior authors in January 2003. Both host and fungal material are preserved in herb. MHU in Uganda. Handmade sections mounted in lactophenol and heated to boiling point were examined by a Zeiss microscope.

Aecidium melleræ Gjørum, sp. nov.

(Fig. 1).

Pycnia epiphylla in maculis cinereo-brunneis, typus 4. *Aecidia hypophylla* in gregibus parvis aggregata, rotundata, peridio brevo, albo, revoluta. *Cellula peridii rhomboideae*, $13\text{--}14 \times 5.5\text{--}6.5 \mu\text{m}$, pariete externo $2\text{--}2.5 \mu\text{m}$ crasso, laeve, pariete interno $1.5 \mu\text{m}$ crasso, verrucoso. *Aecidiosporae* $11\text{--}15 \times 9\text{--}12 \mu\text{m}$, ellipsoideae, ovoideae vel angulares, pariete hyalino, minus quam $1 \mu\text{m}$ crasso, verruculoso, poris obscuris.

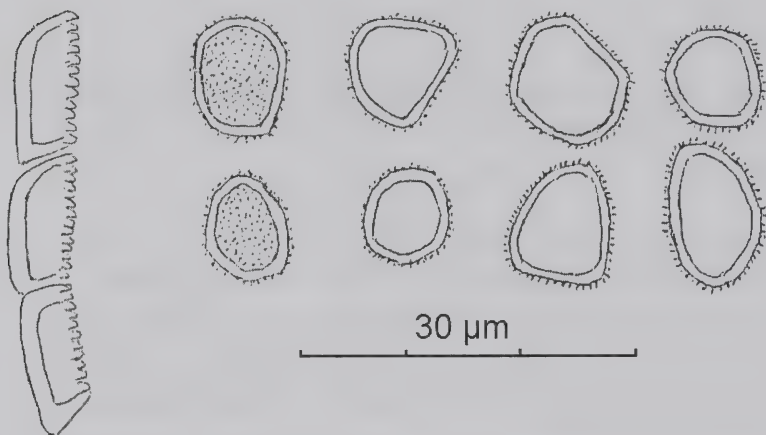


Fig. 1. *Aecidium melleræ* Gjørum, sp. nov. Peridial cells and aeciospores. Drawn from the holotype. Bar $30 \mu\text{m}$.

Pycnia epiphyllous in greyish-brown leaf spots, typus 4. *Aecia* hypophyllous in small groups, round. Peridia short, white, revolute. Peridial cells rhomboid, $13\text{--}14 \times 5.5\text{--}6.5 \mu\text{m}$, outer walls $2\text{--}2.5 \mu\text{m}$ thick, smooth, inner walls $1.5 \mu\text{m}$ thick, verrucose. Aeciospores $11\text{--}15 \times 9\text{--}12 \mu\text{m}$, ellipsoid, ovoid or angularly globoid, walls less than $1 \mu\text{m}$ thick, densely and finely verruculose, hyaline, refractive granules absent, pores obscure.

Holotype: H. B. Gjørum 395 (MHU), Uganda, Elgon: Bugisu, Sironko district, Budadiri county, near National Park border on track to Sasa Hut, 30. Oct. 1970, on *Mellera lobata* S. Moore (*Acanthaceae*).

To our knowledge no rust has previously been recorded on the genus *Mellera*.

Aecidium senecionis-jacksonii Gjørum, sp. nov.

(Fig. 2).

Pycnia ignota. *Aecidia amphigena*, dispersa vel in gregibus parvis aggregata, rotundatae vel ellipsoideae, peridio brevo, albo, revoluta. *Cellula peridii rhomboideae*, $15\text{--}22 \times 10\text{--}20 \mu\text{m}$, pariete externo $4.5\text{--}6.5 \mu\text{m}$ crasso, striato, pariete interno $1.5\text{--}2$

μm crasso, verrucoso. Aecidiosporae $12\text{--}18 \times 10\text{--}14 \mu\text{m}$, ellipsoideae, subgloboideae vel angulares, pariete hyalino, minus quam $1 \mu\text{m}$ crasso, verruculoso, refractivis corpibus $1.5\text{--}2.5 \mu\text{m}$ diametro, poris obscuris.

Pycnia not seen. Aecidiospores amphigenous, scattered or in small groups, round or ellipsoid, peridia short, white, revolute. Peridial cells rhomboid, $15\text{--}22 \times 10\text{--}20 \mu\text{m}$, outer wall $4.5\text{--}6.5 \mu\text{m}$ thick, striate, inner walls $1.5\text{--}2 \mu\text{m}$ thick, verrucose. Aeciospores ellipsoid, subglobose or angular, $12\text{--}18 \times 10\text{--}14 \mu\text{m}$, walls less than $1 \mu\text{m}$ thick, hyaline, verruculose with refractive granules $1.5\text{--}2.5 \mu\text{m}$ in diameter, pores obscure.

Holotype: K. A. Lye, G. Eilu and M. Namaganda in Lye 27662 (MHU), Uganda, Mt. Elgon: Sironko district, Budadiri county, beside Jackson's Pool, $30^{\circ}31' \text{E}$, $1^{\circ}09' \text{N}$, 3930 m, 28. Jan. 2003, on *Senecio jacksonii* S. Moore (*Asteraceae*).

Another specimen examined: *Senecio jacksonii*: Mt. Elgon: Sironko district, below Sasa Hut along path to Mude camp site, $34^{\circ}28.5' \text{E}$, $1^{\circ}11' \text{N}$, 3370 m, 21. Jan. 2003, K. A. Lye, G. Eilu & M. Namaganda in Lye 27656 (MHU).

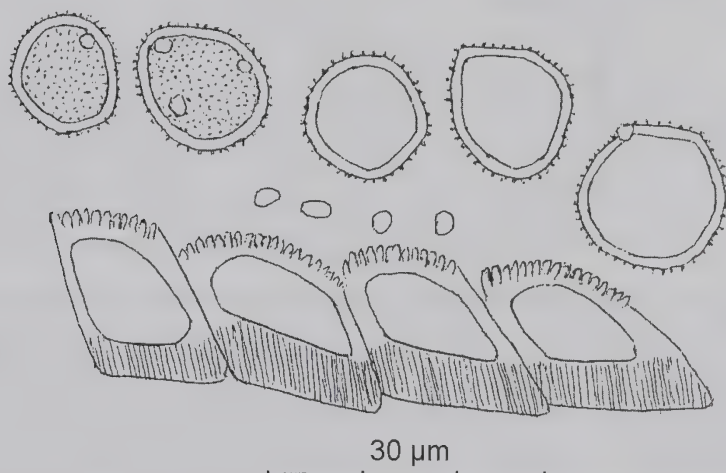


Fig. 2. *Aecidium senecionis-jacksonii* Gjørø, *sp. nov.* Peridial cells, refractive bodies loosened from the spores and aecidiospores. Bar $30 \mu\text{m}$.

Several *Aecidium* spp. are described on hosts of the genus *Senecio*, and quite a few of them are from Africa, but this is the first species found on the genus *Senecio* in the alpine zone in East Africa. From the higher Ugandan mountains only the microcyclic *Puccinia hedbergii* L. Holm on *Dendrosenecio meruensis* (Cotton and Blakelock) Knox and *D. erici-rosenii* (R. & Th. Fries) Knox are known; both hosts belong to the giant senecios, which are tree-like with a woody stem, while the present host is a mat-forming perennial herb (Hedberg 1957).

Puccinia isolepidis Gjørø. – *Lidia* 3: 19, 1990.

On *Isolepis fluitans* (L.) R. Br. (*Cyperaceae*).

Elgon: Sironko district, Budadiri county, 1 km above Mudangi Cliff along path to Sasa river camp site, 2500 m, 26. Jan. 2003, K. A. Lye, G. Eilu and M. Namaganda in Lye 27649, II.

Uredinia on abaxial side of the leaves, roundish or oblong, up to 1 cm long, covered by epidermis which later cracks longitudinally. Urediniospores $20\text{--}25 \times 13\text{--}17 \mu\text{m}$, mostly obovoid, sometimes slightly flattened apically, walls up to $1 \mu\text{m}$ thick, pale yellow, echinulate with 2 equatorial pores.

The specimen corresponds fairly well to the type described on the same host from Ethiopia (Gjærum 1990). This collection is the first record of the species outside Ethiopia.

With these new records a total of 98 rust fungi are known from Mt. Elgon in Uganda (Gjærum 1983–1990; Gjærum et al. 2000–2003; Laundon 1963 & 1965; Wakefield & Hansford 1949).

Acknowledgements

We are most grateful to Professor D. M. Henderson and Professor H. Solheim for reviewing this paper and suggesting improvements.

References

- Gjærum HB. 1983. East African Rusts (*Uredinales*), mainly from Uganda. 1. On *Poaceae*. – Mycotaxon 18: 209–234.
- Gjærum HB. 1984a. East African Rusts (*Uredinales*), mainly from Uganda. 2. On *Cyperaceae*. – Mycotaxon 20: 53–63.
- Gjærum HB. 1984b. East African Rusts (*Uredinales*), mainly from Uganda. 3. On *Amaryllidaceae*, *Commelinaceae*, *Iridaceae*, *Juncaceae*, *Liliaceae*, *Orchidaceae* and *Xyridaceae*. – Mycotaxon 20: 65–72.
- Gjærum HB. 1985. East African Rusts (*Uredinales*), mainly from Uganda. 4. On families belonging to *Apetalae* and *Polypetalae*. – Mycotaxon 24: 237–273.
- Gjærum HB. 1986. East African Rusts (*Uredinales*), mainly from Uganda. 5. On families belonging to *Gamopetalae*. – Mycotaxon 27: 507–550.
- Gjærum HB. 1988. Rust Fungi (*Uredinales*) on *Poaceae*, mainly from Africa. – Mycotaxon 31: 351–378.
- Gjærum HB. 1990. *Puccinia isolepidis*, a new cyperaceous rust species. – Lidia 3: 19–21.
- Gjærum HB, Namaganda M, Lye KA. 2000a. Ugandan rust fungi 2. The genus *Phakopsora*. – Lidia 5: 13–17.
- Gjærum HB, Namaganda M, Lye KA. 2000b. Ugandan rust fungi 4. The genus *Coleosporium*. – Lidia 5: 21–24.
- Gjærum HB, Namaganda M, Lye KA. 2003a. Seven new rust species. – Lidia 6: 13–19.
- Gjærum HB, Namaganda M, Lye KA. 2003b. Additions to the rust flora of Uganda. – Lidia 6: 33–61.
- Hedberg O. 1957. Afroalpine vascular plants. A taxonomic revision. – Uppsala.
- Laundon GF. 1963. Rust fungi I: On *Acanthaceae*. – Mycol. papers no. 89.
- Laundon GF. 1965. Rust fungi III: On *Alangiaceae*, *Amaranthaceae* and *Amaryllidaceae*. – Mycol. papers no. 102.
- Wakefield AM, Hansford CG. 1949. Contributions towards the fungus flora of Uganda. IX. The *Uredinales* of Uganda. – Proceed. Linn. Soc. London, Sess. 161, 1948–49 Pt.2: 162–198.

***Gyalecta canariensis* sp. nov., a new lichen
(Ascomycota) from La Palma (Canary Islands)**

P.P.G. VAN DEN BOOM

Arafura 16, 5691JA, Son, the Netherlands.

A. VĚZDA

*Botanical Institute, Academy of Science
Tábor 28a, CZ-60200 Brno, Czech Republic.*

Abstract — *Gyalecta canariensis*, a corticolous lichen species related to *G. ulmi* and resembling the corticolous, lignicolous and saxicolous *G. truncigena*, is described from the Canary Island, La Palma. This is the first report of a species with more than 8 spores per ascus for the genus.

Key words — Ascomycetes, lichens, species nova, taxonomy

Introduction

The checklist of the Canary Islands (Hernández-Padrón 2001) contains five species of *Gyalectaceae*. *Gyalecta jenensis* (Batsch) Zahlbr. and *G. schisticola* Werner are saxicolous species; *Dimerella lutea* (Dicks.) Trev., *D. pineti* (Ach.) Vězda, and *G. truncigena* (Ach.) Hepp are corticolous. The latter is known from the island of La Gomera only, where it was collected from a *Visnea mocanera* tree. During a field trip to La Palma, an additional member of the genus *Gyalecta*, epiphytic in Laurisilva forest, has been found by the first author.

Taxonomy

***Gyalecta canariensis* van den Boom & Vězda sp. nov.**

Figs. 1–2

Thallus epiphloeodes, corticola, verruculoso-inaequalis, pro parte rimoso-areolatus, albidus. Algae ad Trentepohliam pertinentes cellulis subglobosis, 6–12 μm crassis. Apothecia orbicularia, (0.3–)0.4–0.5 mm lata, in thallo (substrato) semi-immersa, urceolata, margine elevato, dentato, albido, disco concavo, demum plano, nudo, ochraceo vel fusco, epruinoso. Hymenium 70 μm altum, in parte epihymeniali granulis nigris adpersum. Paraphyses 1.5(–2) μm crassae, apicibus capitatis et ad 3 μm crassis, simplices, rarius in parte epihymeniali furcatae. Asci clavati. Ascosporae (8–)12–16: nae, ellipsoideae, 3-septatae, (10–)11–14 x 4.5–5 μm . Pycnidia hyalina, (0.1–)0.15(–0.2) mm. Conidia ellipsoidea 2.5–3.5 x 1.5–2 μm .

Holotypus hic designatus: SPAIN: Canary Islands, La Palma, 8.5 km N of Santa Cruz, Barranco La Galga, cleft in Laurisilva forest, on mature *Ocotea foetens*, 500 m, 5 May 1999, P. & B. v.d. Boom 22435 (LG – holotypus; B, hb. v.d. Boom & hb. Vězda – isotypi).

Thallus corticolous, continuous, effuse, smooth or weakly verrucose, partly rimose-areolate, whitish to grey with a pale brownish tinge, thin (30-)40-60 μm high, cortex not developed, medulla indiscernible. Photobiont *Trentepohlia*, algal cells subglobose, 6-12 μm diam. Apothecia roundish, semi-immersed, urceolate, true exciple initially raised and crenate, becoming entire and level with disc, persistent, concolorous with the thallus, at first pore-like, becoming concave to plane, orange to brown, epruinose, dispersed or grouped, often crowded, margin 50-100 μm wide. Hymenium 70-80 μm high, I + blue, epihymenium with scattered dark granules, hypothecium hyaline, 120 μm high. Paraphyses 1.5(-2) μm wide, simple, scarcely branched especially at the apices, apical cells capitate, up to 3 μm wide. Asci thin-walled, 50-65 x 12-18 μm , clavate, (8-)12-16-spored, apical dome not developed, I-. Ascospores ellipsoid, 3-septate (10-)11-14 x 4.5-5 μm . Pycnidia immersed to semi-immersed, slightly convex, (0.1-)0.15(-0.2) mm diam., concolorous with the thallus, hyaline in section, including the ostiole, conidiogenous cells elongate, 6.5-9 x 2-2.5 μm , conidia short ellipsoid, 2.5-3.5 x 1.5-2 μm .

Chemistry: All chemical reactions in thallus and apothecia are negative. Not examined by TLC.

Ecology: *Gyalecta canariensis* has been found in rather shady Laurisilva woodland in a cleft, on trunks of mature and young *Ocotea foetens* trees. The dominant trees on the collecting site were *Laurus azorica* and *Persea indica*. The accompanying lichen species on the same tree, growing close to *G. canariensis*, were *Belonia lumbrisporea*, *Caloplaca* sp., *Opegrapha varia* and *Porina guaranitica*.

Discussion

General data about the genus are provided in the most recent treatment of the genus (Ryan & Nimis 2004). The asci of the c. 65 species worldwide are 8-spored. The world distribution is circumarctic to temperate.

The new species described here is characterized by the mainly 12-16-spored asci in combination with the relative short, 3-septate ascospores and the thin, smooth and continuous thallus. The 12-16-spored asci are unique, and reported here for the first time for the genus (see Fig. 2).

Gyalecta canariensis is most closely related to *G. ulmi* which is sometimes also corticolous. *G. ulmi* has larger apothecia (0.6-1.6 mm), larger ascospores (15-20 x 5-7 μm), 8-spored asci and pruinose apothecia. Although *G. ulmi* is known from Iberian Peninsula, so far it has not been reported from the Canary Islands. Confusion is possible with *G. truncigena*, known from the Canary Island La Gomera, a species with a somewhat similar habitus, but the ascospores are sparingly muriform, the asci are 8-spored and the apothecia are immersed. Another *Gyalecta* species with 3-septate ascospores is *G. foveolaris*, but this species is characterized by the coarsely verrucose-granular, not cracked or rimose, and often pruinose thallus, the wider ascospores (5-6(-7) μm) and the 8-spored asci. In addition, the ecology of *G. foveolaris* is different, overgrowing mosses and soil on acid rocks. Two further species with 3-septate ascospores, *G. peziza* (Mont.) Anzi and *G. friesii* Flot. ex Körb. are known from northern and central Europe but their ascospores are larger and they occur on soil or acidic rock.

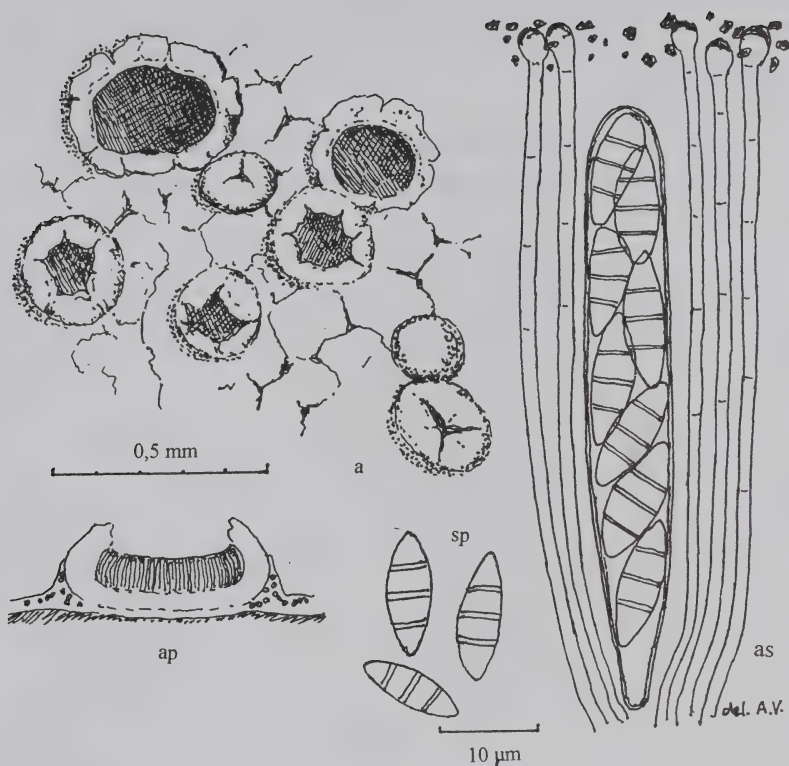


Fig. 1. *Gyalecta canariensis* (holotype : a, habitus; ap, vertical section through an apothecium; as, ascus with paraphyses; sp, ascospores). Drawing by A. Vězda.

Additional specimen examined: La Palma, La Galga, cleft in Laurisilva forest, on smooth bark of young *Ocotea foetens*, 4 May 1999, P. v.d. Boom 22427 (hb. v.d. Boom).

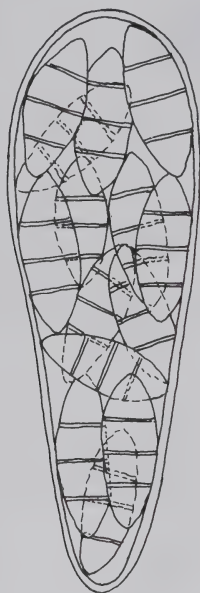
Acknowledgements

We would like to thank Prof. Dr. Ted Esslinger (Fargo) and Dr. Harrie Sipman (Berlin) for presubmission reviews.

Literature cited

- Etayo J. 1998. Aportación a la flora líquénica de las Islas Canarias. IV. Líquenes epífitos de La Gomera (Islas Canarias). - *Tropical Bryology* **14**: 85-107.
- Hernández-Padrón CE. 2001. División Lichenes y Lichenicolous fungi. - In: Izquierdo I., Martín JL, Zurita N. & Arechavaleta M. (eds.). Lista de especies silvestres de Canarias (hongos, plantas y animales terrestres). - Consejería de Política Territorial y Medio Ambiente. Gobierno de Canarias. pp 63-87.

- Limona X. & Hladun NL. 2001. Checklist of the lichens and lichenicolous fungi of the Iberian Peninsula and Balearic Islands. - *Bocconeia* **14**: 1–581.
- Ryan BD. & Nimis PL. 2004. *Gyalecta*. – In: Nash TH, Ryan BD, Diederich P, Gries C. & Bungartz F. (eds.). Lichen Flora of the Greater Sonoran Desert Region. Volume **2**. - Tempe: Lichens Unlimited.



10 μ m

Fig. 2. *Gyalecta canariensis* (Isotype: ascus with 14 ascospores). Drawing by P.P.G. van den Boom.

A new *Ophiostoma* species isolated from *Pinus pinaster* in the Iberian Peninsula

M. VILLARREAL¹, V. RUBIO¹, M.T. DE TROYA² & F. ARENAL¹

¹*mvillarr@ccma.csic.es, vrubio@ccma.csic.es, farenal@ccma.csic.es*
Dpto. Protección Vegetal, Centro Ciencias Medioambientales (CCMA-CSIC)
Serrano, 115, Madrid, E-28006, Spain

²*mtroya@inia.es*

Centro Investigación Forestal
Instituto Nacional Investigación y Tecnología Agraria y Alimentaria
CIFOR-INIA, Apdo. 8111, Madrid, E-28080, Spain

Abstract — An unknown species was isolated from *Pinus pinaster* infested by *Tomicus piniperda* (Coleoptera: *Scolytidae*) in Central Spain. The new taxon is distinguished from other species by morphological features as well as by phylogenetic analysis of aligned sequences of the ITS region of the rRNA operon. Taxonomic implications are discussed, and the new combinations *O. allantosporum*, *O. angusticollis*, *O. coronatum* and *O. tenellum*, are proposed.

Key Words — *Ophiostoma sejunctum*, phylogeny, taxonomy

Introduction

Ophiostoma Syd. & P. Syd. species are economically important causal agents of blue-stain in living conifers and lumber (Seifert 1993), and also include species causing root, vascular wilt or vascular stain diseases (Harrington 1988). Many of these species are commonly associated with different bark beetles (Coleoptera: *Scolytidae*) that particularly infest trees. One of the most common beetle species that aggressively attack stressed pines in Spain is *Tomicus piniperda* L. (Ritzerow & Stauffer 2003). The insect is commonly the transmission vector of some *Ophiostoma* species such *O. minus* (Hedgec.) Syd. & P. Syd. and can contribute to rapid tree death (Solheim & Långström 1991, Långström et al. 1993, Solheim et al. 1993). During a survey searching for fungi causing blue-stain and mortality in *P. pinaster* Ait. populations in central Spain, several *Ophiostoma* species, such as *O. piceae* (Münch) Syd. & P. Syd., *O. minus* and *O. deltoideosporum* (Olchow. & J. Reid) Georg Hausner, J. Reid & Klassen, were collected occurring together with the new proposed species.

Mediterranean forests in Spain exhibit a high fungal diversity in several taxonomic groups (Greuter 1991, Peláez et al. 1998, Villarreal et al. 2002), but there are only two references concerning ophiostomatoid fungi in conifer forests (De Ana Magán 1982; 1983) concerning *Leptographium gallaeiciae* Fern. Magán nom. inval. (no type material designed) growing on *Pinus pinaster*, and later synonymized to *Ophiostoma serpens* (Goid.) Arx by Jacobs & Wingfield (2001).

Materials and Methods

Fungal isolation and growth conditions. Blue-stained wood blocks of recently dead *P. pinaster* were incubated in moist chambers for one month at 23°C. After fructification, ascospore masses at the tips of ascocarps were transferred to 2% malt extract plates (MEA). Resulting colonies, were transferred to new MEA Petri dishes. The strains were incubated at 24°C and 80% r.h. and were preserved as frozen agar plugs in 20% glycerol at -80°C. Dried material is deposited at the herbarium of the University of Alcalá de Henares (AH). The *Ophiostoma* strains used in this study and the GenBank accession numbers of their ITS sequences are shown in Table 1. The isolate was grown in the dark, and the colony radius was measured at 1, 2 and 3 weeks at 10, 15, 20, 25, 30, and 35°C. Each growth-rate experiment was repeated three times and the results averaged for each temperature.

Morphological observations. Slides were prepared on lactophenol cotton blue and observed under a Leitz Diaplan microscope. Photographs were made with an Olympus DP-12 digital camera system incorporated to the Leitz microscope.

DNA amplification and sequencing. DNA extraction procedure was carried out as described in (Boysen et al. 1996). The primers used for amplification the ITS region were ITS1F (Gardes & Bruns 1993), and ITS4 (White et al. 1990). PCR conditions were the following: step 1) 2.5 min at 94°C; step 2) 40 cycles of: 15s at 94°C, followed by 30s at 58°C and 1.5 min at 72°C; step 3) 10min at 72°C. Resulting products were purified using GFX™ PCR gel band purification Kit (Amersham Pharmacia Biotech Inc, USA). The amplification products were sequenced using ITS2, ITS3, ITS4, ITS5 primers with the ABI PRISM Dye Terminator Cycle Sequencing Kit on automatic sequencer ABI PRISM 373 (Perkin Elmer Applied Biosystems). Sequences were edited using Edit View v. 1.0.1. (Applied Biosystems) and assembled using the GCG Seqed package (Wisconsin Package, V.8) and corrected manually after examining electropherograms.

Phylogenetic analysis. The alignment was performed using the multiple alignment program CLUSTAL X 1.81 (Thompson et al. 1997) and corrected manually using BIOEDIT ver. 5.0.9 software (Hall 1999). Gaps were treated with simple indel coding method proposed by Simmons & Ochoterena (2000) using GAP CODER software (Young & Healy 2001). The phylogenetic analysis was performed by the maximum parsimony method using the heuristic search algorithm of PAUP* ver. 4.0 b10 software (Swofford 2001). Heuristic search was performed with simple addition sequences and TBR branch swapping, with MaxTrees set to 1000. All characters were unordered and equally weighted, with gaps treated as missing data. The trees were rooted with *Ophiostoma ips* (CCMA333) as outgroup. The data were resampled with 1000 bootstrap replicates (Felsenstein 1985) and decay index was calculated using TreeRoot ver. 2 (Sorenson 1999).

Taxonomy and Results

Ophiostoma sejunctum M. Villarreal, Arenal, V. Rubio & M. de Troya **sp. nov.**
(Figs 1-8)

Perithecia in ligno vel sub cortice, superficialia, aggregata vel singulares; basis globosae, inornatae vel sparsissima ornatone, atra, 60-75 (-95) µm in diam.; collum

Table 1. *Ophiostoma* strains used in the study.

Species	Strain	GenBank	Substrate
<i>C. brunnea</i>	CBS161.61	AY924381	<i>Abies</i> sp. USA
<i>O. abietinum</i>	CBS125.89	AY924382	<i>Abies vejari</i> . Mexico
<i>O. allantosporum</i>	CBS185.86	AY934506	<i>Pinus resinosa</i> . USA
<i>O. angusticollis</i>	CBS186.86	AY924383	<i>Pinus banksiana</i> . USA
<i>O. arduennense</i>	MUCL45362	AY573247	<i>Fagus sylvatica</i> . Belgium
<i>O. bacillisporum</i>	MUCL45378	AY573258	<i>Fagus sylvatica</i> . Belgium
<i>O. canum</i>	MUCL18759	AJ538342	<i>Pinus sylvestris</i> . Norway
<i>O. catonianum</i>	CBS263.35	AF198234	<i>Pyrus</i> sp. Italy
<i>O. conicola</i>	CBS127.89	AY924384	<i>Pinus cembroides</i> . Mexico
<i>O. coronatum</i>	CBS497.77	AY924385	Unknown. Canada
<i>O. distortum</i>	DSMZ4897	AY924386	<i>Abies concolor</i> . USA
<i>O. fusiforme</i>	CMW9968	AY280481	Unknown.
<i>O. flexuosum</i>	CBS208.83	AY924387	<i>Picea abies</i> . Norway
<i>O. floccosum</i>	CNB117	AJ538343	<i>Pinus pinaster</i> . Spain
<i>O. gossypinum</i> var. <i>robustum</i>	MUCL18357	AY924388	<i>Pinus ponderosa</i> . USA
<i>O. grandicarpum</i>	D	AJ293884	<i>Quercus</i> sp. Europe
<i>O. himal-ulmi</i>	HP27	AF198234	<i>Ulmus</i> sp. India
<i>O. ips</i>	CCMA333	AY934507	<i>Pinus pinea</i> . Spain
<i>O. kryptum</i>	IFFF/Hasd1	AY304437	<i>Larix decidua</i> . Austria
<i>Ophiostoma</i> sp.	CCMA27	AY934508	<i>Pinus nigra</i> . Spain
<i>O. lunatum</i>	CMW10564	AY280486	<i>Larix decidua</i> . Austria
<i>O. lunatum</i>	CMW10563	AY280485	<i>Larix decidua</i> . Austria
<i>O. minus</i>	AU58.4	AF234834	<i>Pinus</i> sp. Canada
<i>O. minus</i>	PIR	AY934509	<i>Pinus sylvestris</i> . Spain
<i>O. minus</i>	VA	AY934510	<i>Pinus sylvestris</i> . Spain
<i>O. minus</i>	CCMA12	AY934511	<i>Pinus nigra</i> . Spain
<i>O. multiannulatum</i>	MUCL19062	AY934512	<i>Pinus</i> sp. USA
<i>O. narcissi</i>	IMI349579	AF484451	<i>Narcissus</i> sp. UK
<i>O. nigrocarpum</i>	CBS409.77	AY934513	<i>Pinus ponderosa</i> . USA
<i>O. novo-ulmi</i>	C510	AF198236	<i>Ulmus</i> sp. USA
<i>O. perfectum</i>	CBS636.66	AY934514	<i>Picea engelmannii</i> . USA
<i>O. piceae</i>	CNB15	AY934515	<i>Pinus sylvestris</i> . Spain.
<i>O. piliferum</i>	CCMA32	AY934516	<i>Pinus sylvestris</i> . Spain
<i>O. pluriannulatum</i>	MUCL18372	AY934517	Conifer. USA
<i>O. querci</i>	CMW7660	AF493252	<i>Pinus</i> sp. New Zealand
<i>O. rostricoronatum</i>	CBS434.77	AY194509	<i>Acer</i> sp.
<i>O. sejunctum</i>	OPHI1A-AH32772	AY934519	<i>Pinus pinaster</i> . Spain
<i>O. sejunctum</i>	OPHI1B-AH32773	AY934520	<i>Pinus pinaster</i> . Spain
<i>O. setosum</i>	CBS102.358	AY934518	<i>Pseudotsuga menziesii</i> . USA
<i>O. ssiori</i>	MAFF410972	AB096208	<i>Prunus</i> sp. Japan
<i>O. stenoceras</i>	MUCL9530	AY934526	<i>Pinus pinaster</i> . Spain
<i>O. stenoceras</i>	CCMA110A	AY934521	<i>Pinus pinaster</i> . Spain
<i>O. subalpinum</i>	MAFF410924	AB096211	<i>Prunus</i> sp. Japan
<i>O. subannulatum</i>	CBS188.86	AY934522	<i>Pinus</i> sp. USA
<i>O. tenellum</i>	CBS189.86	AY934523	<i>Pinus banksiana</i> . USA
<i>O. tetropii</i>	CBS428.94	AY934524	<i>Picea abies</i> . Austria
<i>O. triangulosporum</i>	DSMZ4934	AY934525	<i>Araucaria araucana</i> Brazil
<i>O. ulmi</i>	CBS102.63	AF198232	<i>Ulmus</i> sp. Netherlands
<i>S. schenckii</i>	CMW7617	AF484471	From soil. South Africa

fuscum vel atrum, rectum, leve, 100-250 (-350) μm longum, 10-14 μm ad basim, 5-7 μm ad apicem latum; hyphae ostiolaris non visi. Asci non visi. Ascospores hyalinae, aseptatae, allantoidae, sine vagine gelatinosa, 2-2,5 x 0,7-1,2 μm in apice colli conglobatae. Coloniae in culturo agar albae, mycelio adpresum, superficiali. Conidiophora status Hyalorhinocladia, hyalina, simplicia, evenientia singulatim ariis myceliis, conidiophora 6-11 (-42) μm longa et 1-3 μm lata, conidia formantes percurrentur in cellis conidiogenis. Conidia hyalina, unicellulata, holoblastica, obovoidea vel elliptica 1-5 (-7) x 0,7-2 (-3) μm .

TYPUS (hic designatus): Spain: Madrid, El Escorial, sapwood of standing dead *Pinus pinaster* infested by *Tomicus piniperda*, 24-4-03, M.R. Boreal. (AH32772 holotypus). Anamorphic state *Hyalorhinocladia*.

Etymology: from Latin “*sejunctus*” = different to the rest.

Perithecia superficial or partly immersed in the wood, with globose to subglobose base, 60-75 (-95) μm wide, black, with peridium made up 3-7 μm polygonal cells, covered by a thick layer of brown hyphae up to 40 μm long, individual hyphae 1-2.5 μm wide, with thick walls and septa near the base, thinner towards the rounded apical cells, mostly unbranched. The perithecial necks dark brown to black, cylindrical, smooth, straight or curved, slightly tapering towards the apex, 100-250 (-350) μm long, 10-14 μm wide at the base and 5-7 μm at the apex, ostiolar hyphae absent, with a slightly broader open apex. Ascospore slime is at first hyaline, then milky white and dries yellowish. Asci not observed. Ascospores hyaline, allantoids, 2-2.5 x 0.7-1.2 μm , lacking a gelatinous sheath or secondary wall.

Colonies on 2% MEA, superficial and immersed, hyaline to white, glistening as a result of copious production of conidia in slime, agar not pigmented, growth rate slow, 1.3 mm in diameter after two weeks at 20°C. Mycelial anamorph is referable to *Hyalorhinocladia* produced an adpressed mycelium, or growing amongst the hyphae at the base of the perithecia, sometimes occurring from the ascomatal necks or ascospore masses. Conidiogenous cells are hyaline, 6-11 (-42) x 1-3 μm , terminal or intercalated. Conidia hyaline, aseptate, obovoid to ellipsoid, sometimes with a slight median constriction, frequently are solitary or in nodes, 1-5 (-7) x 0.7-2 (-3) μm . Cardinal temperatures: $\leq 5^\circ$ minimum, optimum 25°, maximum $\geq 30^\circ$.

Specimens examined: OPHI 1A; Spain, El Escorial, Madrid, sapwood of dead standing *Pinus pinaster* infested by *Tomicus piniperda*, 24-4-03, M.R. Boreal. (AH32772 holotypus). Ibidem OPHI1B; 25-6-03, M. Villarreal (AH32773).

The genera *Ceratocystis* and *Ophiostoma* have long been considered synonymous, and several species have been transferred from one genus to the other. But many others *Ophiostoma* species are still retained in *Ceratocystis*. Some of them treated in this work, according to the molecular results obtained, are transferred to *Ophiostoma* as follows:

Ophiostoma allantosporum (H.D. Griffin) M. Villarreal **comb. nov.**

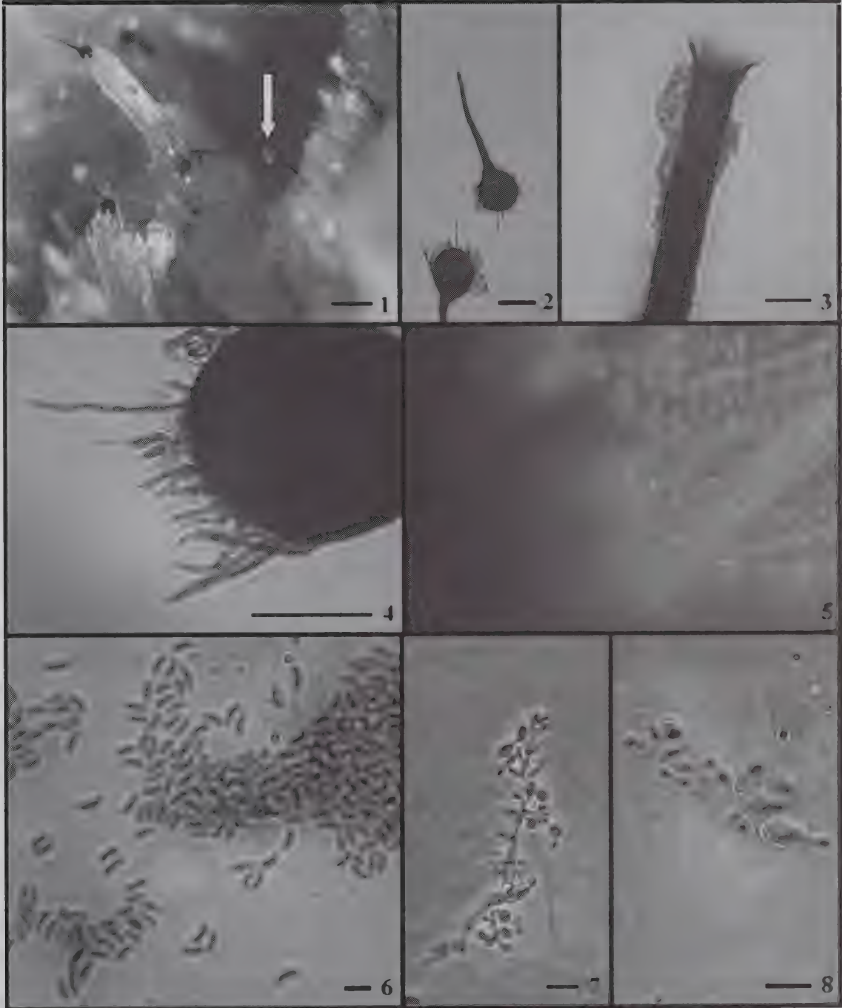
= *Ceratocystis allantospora* H.D. Griffin, Can. J. Bot. 46: 694. 1968.

Ophiostoma angusticollis (E.F. Wright & H.D. Griffin) M. Villarreal **comb. nov.**

= *Ceratocystis angusticollis* E.F. Wright & H.D. Griffin Can. J. Bot. 46: 697. 1968.

Ophiostoma coronatum (Olchow. & J. Reid) M. Villarreal **comb. nov.**
 = *Ceratocystis coronata* Olchow. & J. Reid Can. J. Bot. 52: 1705. 1974.

Ophiostoma tenellum (R.W. Davidson) M. Villarreal **comb. nov.**
 = *Ceratocystis tenella* R.W. Davidson, Mycologia 50: 666. 1958.
 = *Ceratocystis capitata* H.D. Griffin, Can. J. Bot. 46: 699. 1968.



FIGS. 1-8. *Ophiostoma sejunctum* (holotype). 1. Appearance of ascomata on the wood surface. Arrow show apical ascospore drop. 2. Perithecia on slide mount. 3. Detail of neck apex with emerging ascospores. 4. Peridial ornamentation. 5. Cultural characteristics. 6. Ascospores. 7. *Hyalorhinocladia* anamorph with primary and secondary conidia. 8. Conidia. Scale bars: 1 = 250 μ m, 2 = 75 μ m, 3 = 5 μ m, 4 = 40 μ m, 6 = 2 μ m, 7 = 10 μ m, 8 = 5 μ m.

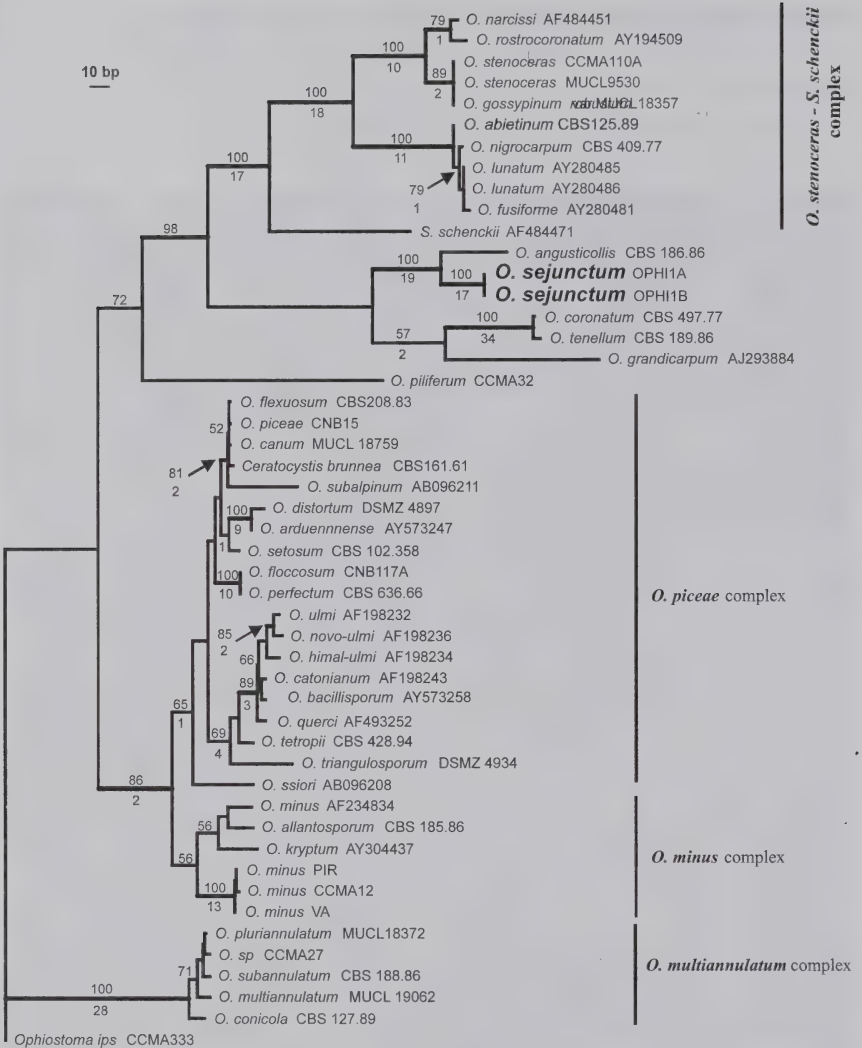


Fig. 9. Phylogenetic tree generated by parsimony analyses using the ITS1-5.8S-ITS2 sequences. Bootstrap values $\geq 50\%$ indicated above the branches, values $\geq 75\%$ are bolder, and decay index indicated below. The scale bar indicates ten nucleotide substitution.

Amplifications of the ITS regions resulted in fragments about 650 base pairs. The aligned data set consisted of 698 characters. Using simple indel coding, a total of 177 gaps and indels were coded and added to the matrix, resulting in a aligned data set of 875 characters, including 344 constant characters, 376 parsimony informative characters and 155 uninformative characters. A heuristic search of the data set resulted in 100 most parsimonious trees of 1205 steps (CI = 0.616, RI = 0.830, HI = 0.384).

Discussion

Ophiostoma sejunctum is characterized by its allantoid ascospores and the presence of a *Hyalorhinocladia* anamorphic state as well as the presence of secondary and tertiary conidia. Morphologically and phylogenetical analyses of the ITS region show that *O. sejunctum* is close to *O. angusticollis*. Both taxa are similar in perithecial and culture features, having the base of the ascocarps about 100 µm in diameter, necks usually less than 500 µm long, ascospores without sheath, and mononematous mycelial anamorph. Olchowecki & Reid (1974) mentioned the presence of a hyaline gelatinous pad capping the apices of the perithecial necks of *O. angusticollis*, being not observed in the new species. Microscopically, *O. angusticollis* have ascospores orange-section-shaped in side view, while *O. sejunctum* spores are allantoid. The anamorph of *O. angusticollis* was not originally described because cultures were not obtained, but later, Olchowecki & Reid (1974) described the conidiogenous cells denticulate, with denticles up to 0.5 x 0.7-1 µm, and Upadhyay (1981) describe evident denticles up to 1.5 µm long corresponding to a *Sporothrix* anamorph, observed in CBS 186.86 strain. Due to the absence of conidiogenous cells with denticles in the anamorph of *O. sejunctum*, and the predominant annellidic conidiogenesis, the anamorph is well accommodated in *Hyalorhinocladia*. Consistently, according to the whole data set, both taxa are different.

Phylogenetically both species appears together in a distant clade from the *Ophiostoma piceae*-complex (Harrington et al. 2001), and the *O. multiannulatum*-complex. Moreover, both taxa are grouped in a well supported sister clade with the *Ophiostoma stenoceras*-*Sporothrix schenckii*-complex (de Beer et al. 2003) and other species.

Olchowecki & Reid (1974) distinguished *O. angusticollis* from *O. albidum* Math.-Kåårik based on morphological features, but De Hoog (1974) and Upadhyay (1981), treated this species as a synonym of *O. stenoceras*. The possibility that the new taxon could be *O. albidum* has been descarted, on account of the recent molecular studies demonstrating that original material of *O. albidum* from Mathiesen-Kåårik is conspecific with *O. stenoceras* (De Beer et al. 2003).

Similar secondary and tertiary conidia of *O. sejunctum* are frequent in species such as *O. multiannulatum* (Hedgc. & R. W. Davidson) Hendr., *O. conicola* Marmolejo & Butin, *O. subannulatum* Livingston & R.W. Davidson, *O. novae-zelandiae* (L.J. Hutchison & J. Reid) Rulamort, *O. retusum* (R.W. Davidson & T.E. Hinds) Georg Hausner, J. Reid & Klassen, *O. pluriannulatum* (Hedgc.) Syd. & P. Syd., *O. californicum* (DeVay, R.W. Davidson & W.J. Moller) Georg Hausner, J. Reid & Klassen and *O. populinum* (T.E. Hinds & R.W. Davidson) de Hoog & R.J. Scheff., (members of the *O. multiannulatum*-complex) and all of them are characterized by the presence of longer necks and a *Sporothrix* anamorph with or without synnematus synanamorph. Molecular data analyzed show no phylogenetic relationship between *O. sejunctum* and the *Ophiostoma* species above mentioned.

Morphologically, *O. sejunctum* also resembles *O. allantosporum* in having a *Hyalorhinocladia* anamorphic state, allantoid ascospores without sheaths, and lacking ostiolar hyphae at the tips of the perithecial necks. However, the perithecia of *O. allantosporum*, which have longer necks than those of *O. sejunctum*, reach up to

4000 μm in length (Griffin 1968). The ascospore shape and size of *O. allantosporum* are similar, being slightly longer than *O. sejunctum*, but overlapping considerably. With respect to conidial length, *O. allantosporum* conidia are longer ($\sim 12 \mu\text{m}$) than the shorter ($\sim 6.5 \mu\text{m}$) *O. sejunctum* conidia. *O. sejunctum* colonies resemble those described for *O. allantosporum* in having a slow growth rate, no agar pigmentation, and an appressed white mycelium with glistening slimy aspect. But comparison with type material has not been possible due to the absence of a type culture collection. Upadhyay (1981) described some dark-brown pigmented patches with a pale olive reverse appearing as result of the ascocarp development that are absent in the newly described species. The analyzed strain of *O. allantosporum* (CBS 185.86) presented an abundant aerial mycelium and mid-brown pigmented hyphae that are also absent in *O. sejunctum*. Moreover, based on ITS sequences, both species are phylogenetically distant, with *O. allantosporum* clustered in the *O. minus*-complex with *O. minus* (European heterothallic strains CCMA12, VA & PIR and American homothallic strain (?) AF 234834) and *O. kryptum* K. Jacobs & Kirisits.

Recently, other new species with the *Hyalorhinoeladiella* anamorph have been described or rediscovered (see Kirschner & Oberwinkler 1999, Gebhardt et al. 2002, Jacobs & Kirisits 2003), and Jacobs et al. 2003), but all these species differ greatly from *O. sejunctum* from a morphological and/or molecular viewpoint.

Although *O. sejunctum* was isolated from recently dead *Pinus pinaster*, nothing is known regarding the pathogenicity of this species. Its relationship with *T. piniperda* must be demonstrated. The blue-stain seen in the wood was principally caused by *O. minus* and *O. piceae*, and the isolation together *O. deltoideosporum* (only reported from North America) leads us to assume that the fungus might have been accidentally introduced, which must be still verified.

Acknowledgements

We thank Dr. Rodríguez Barea (Escuela de Ingenieros de Montes, Polytechnics University of Madrid) and Servicio de Jardines, Parques y Montes del Patrimonio Nacional, for kindly providing material. We also thank to Dr. T. Harrington (Dpt. of Plant Pathology, Iowa State University) for checking the ITS sequences with his extensive sequence data base of Ophiostomatoid fungi. This study was partially financed by the Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA), Grant No SC00-054-C3-2. Furthermore, we want to express our gratitude to Dr. J. Checa (Dpt. of Botany, Alcalá University), and to Dr. F. Peláez and Dr. G. Platas (CIBE, Merck Sharp & Dohme), for the review of the manuscript and their useful comments.

References

- De Ana Magán FJF. 1982. Las hogueras en el monte y el ataque del hongo *Leptographium gallaeciae* sp. nov. Sobre *P. pinaster* Ait. Bol. Serv. Plagas 8:69-92.
- De Ana Magán FJF. 1983. Enfermedad del *Pinus pinaster* en Galicia *Leptographium gallaeciae* F. Magan sp. nov. An. INIA/Ser. Forestal 7:165-169.
- De Beer ZW, Harrington TC, Vismner HF, Wingfield BD, Winfield M. 2003. Phylogeny of the *Ophiostoma stenoceras*-*Sporothrix schenckii* complex. Mycologia 95(3):434-441.
- De Hoog GS. 1974. The genera *Blastobotrys*, *Sporothrix*, *Calcarisporium* and *Calcarisporiella* gen. nov. Stud. Mycol. 7: 1-84.

- Boysen M, Borja M, del Moral C, Salazar O, Rubio V. 1996. Identification at strain level of *Rhizoctonia solani* AG4 isolates by direct sequence of asymmetric PCR products of the ITS regions. *Curr. Genet.* 29: 174-181.
- Felsenstein J. 1985. Confidence intervals on phylogenies: an approach using the bootstrap. *Evolution* 39:783-791.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for Basidiomycetes-application to the identification of mycorrhizae and rusts. *Mol. Ecol.* 2: 113-118
- Gebhardt H, Kirschner R, Oberwinkler F. 2002. A new *Ophiostoma* species isolated from the ambrosia beetle *Xyleborus dryographus* (Coleoptera: Scolytidae). *Mycol. Prog.* 1(4):377-382.
- Greuter W. 1991. Botanical diversity, endemism, rarity and extinction in the Mediterranean area: An analysis based on the publication volumes of Med-Checklist. *Bot. Chron.* 10: 63-69.
- Griffin HD. 1968. The genus *Ceratocystis* in Ontario. *Can. J. Bot.* 46:689-718.
- Hall TA. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucl. Acids. Symp. Ser.* 41:95-98.
- Harrington TC. 1988. *Leptographium* species, their distributions, host and insect vectors. In: Harrington, T.C. Cobb, FW. Jr. *Leptographium: root diseases on conifers*. APS Press, St. Paul: 1-39.
- Harrington TC, McNew D, Steimel J, Hofstra D & Farrell R. 2001. Phylogeny and taxonomy of the *Ophiostoma piceae* complex and the Dutch Elm disease fungi. *Mycologia* 93:111-136.
- Jacobs K, Kirisits T. 2003. *Ophiostoma kryptum* sp. nov. from *Larix decidua* and *Picea abies* in Europe, similar to *O. minus*. *Mycol. Res.* 107(10):1231-1242.
- Jacobs K, Wingfield M. 2001. *Leptographium* species. Tree pathogens, insect associates, and agents of blue-stain. APS Press, St. Paul, Minn.
- Jacobs K, Seifert KA, Harrison KJ, Kirisits T. 2003. Identity and phylogenetic relationships of ophiostomatoid fungi associated with invasive and native *Tetropium* species (Coleoptera: Cerambycidae) in Atlantic Canada. *Can. J. Bot.* 81:316-329.
- Kirschner R, Oberwinkler F. 1999. A new *Ophiostoma* species associated with bark beetles infesting Norway spruce. *Can. J. Bot.* 77:247-252.
- Långström B, Solheim H, Hellqvist C, & Gref R. 1993. Effects of pruning young Scots pines on host vigour and susceptibility to *Leptographium wingfieldii* and *Ophiostoma minus*, two blue-stain fungi associated with *Tomicus piniperda*. *Eur. J. For. Path.* 23:400-415.
- Olchowecki A, Reid J. 1974. Taxonomy of the genus *Ceratocystis* in Manitoba. *Can. J. Bot.* 52:1675-1711.
- Peláez F, Collado J, Arenal F, Basilio A, Cabello A, Díez Matas MT, García JB, González del Val A, González V, Gorrochategui J, Hernández P, Martín I, Platas G & Vicente F. 1998. Endophytic fungi from plants living on gypsum soils as a source of secondary metabolites with antimicrobial activity. *Mycol. Res.* 102: 755-761
- Ritzrow S, Stauffer C. 2003. Phylogeographische Untersuchungen an *Tomicus piniperda*. In: DGaE: Deutsche Entomologentagung, 03/2003, Halle, 14, 1
- Seifert KA. 1993. Sapstain of commercial lumber by species of *Ophiostoma* and *Ceratocystis*. In: Wingfield MJ, Seifert KA, Webber JF. *Ceratocystis* and *Ophiostoma*. Taxonomy, ecology, and pathogenicity. American Phytopathological Society (APS), St Paul:153-160.
- Simmons MP, Ochoterena H. 2000. Gaps as characters in sequence-based phylogenetic analyses. *Syst. Biol.* 49: 369-381.
- Solheim H, Långström B. 1991. Blue-stain fungi associated with *Tomicus piniperda* in Sweden and preliminary observations on their pathogenicity. *Annales de Sciences Forestieres* 48:149-156.

- Solheim H, Långström B, Hellqvist C. 1993. Pathogenicity of the blue-stain fungi *Leptographium wingfieldii* and *Ophiostoma minus* to Scots pine: effect of the pruning and inoculum density. *Can. J. For. Res.* 23: 1438-1443.
- Sorenson MD. 1999. TreeRot, version 2. Boston University, Boston, M.A.
- Swofford DL. 2001. PAUP*, Phylogenetic Analysis using Parsimony (* and Other Methods). Ver. 4. Sinauer Associates, Sunderland, MA.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nuc. Acids. Res.* 24: 4876-4882.
- Upadhyay HP. 1981. A monograph of *Ceratocystis* and *Ceratocystiopsis*. University of Georgia Press, Athens, Ga.
- Villarreal M, Arenal F, Rubio F. 2002. *Mycena pinophila*, a new species of *Mycena* section *Polyadelphia* from Spain. *Mycotaxon* 84: 331-336.
- White TJ, Bruns T, Lee S & Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In *PCR Protocols: A Guide to Methods and Amplifications* (eds. MA Innis, DH Gelfand, JJ Sninsky, TJ White). pp 315-322. Academic Press. New York.
- Young ND, Healy J. 2001. Incorporating indels as characters in phylogeny and the search for the best multiple sequence alignment. *Botany 2001 Abstracts*, 627. Bot. Soc. Amer.

Two new species of *Urocystis* (*Urocystales*) from China

LIN GUO

guol@sun.im.ac.cn

Key Laboratory of Systematic Mycology & Lichenology, Institute of Microbiology
Chinese Academy of Sciences, Beijing 100080, China

Abstract—Two new species, *Urocystis koeleriae* on *Koeleria litvinowii* and *Urocystis sinensis* on *Anemone rivularis* are described.

Key words—smut fungi, taxonomy

A species of *Urocystis* on *Koeleria litvinowii* was collected in Qinghai Province in 2004. The host plant *Koeleria* belongs to the tribe *Aveneae* of *Pooideae*. Fischer (1953:209) considered the species on *Koeleria cristata* from the USA to be *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh. According to the present concept (Vánky 1994), the species *U. agropyri* is restricted to the host plants in the genera *Elymus*, *Roegneria*, *Elytrigia* and *Clinelymus* belonging to the tribe *Triticeae* in the subfamily *Pooideae*. Spore balls are mostly 1-ustilospored (0=0.5%, 1=55%, 2=35.5%, 3=7.5%, 4=1%, 5=0.5%, Vánky 1994:283) in *U. agropyri*, while in the species of *Urocystis* on *Koeleria* spore balls are mostly 2-ustilospored (0=4%, 1=38%, 2=44%, 3=10%, 4=3%, 5=1%, n=100). The species on *Koeleria* differs mainly from *U. agropyri* in different ustilospore percentage of the spore balls and the different tribe of the host plant. A new species of *Urocystis* is described:

Urocystis koeleriae L. Guo, sp. nov.

Figs. 1-2

Sori in foliis, primo epidermide obtectas, deinde rupturas. Massa sporarum nigrobrunnea, pulverulenta. Glomeruli sporarum subglobosi, ellipsoidei, ovoidei vel irregulares, 19.5-38.5 x 15-30.5 µm, e ustilosporis (0)1-4(-5) constructi, cellulis sterilibus fere omnino circumdati. Ustilosporae subglobosae, globosae, ellipsoideae, ovoideae vel elongatae, 11-19(-20.5) x 10-15 µm, rubrobrunneae. Cellulae steriles subglobosae, ellipsoideae vel elongatae, 5.5-13 x 5-10 µm, flavidobrunneae; pariete ca. 0.5-1.5 µm crasso, levi.

Sori in leaves, forming long striae between the veins, at first covered by the epidermis, which later ruptures. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or irregular, 19.5-38.5 x 15-30.5 µm, composed of (0)1-4(-5) ustilospores (0=4%, 1=38%, 2=44%, 3=10%, 4=3%, 5=1%; n=100), nearly completely surrounded by sterile cells. Ustilospores subglobose, globose, ellipsoidal, ovoid or elongated, 11-19(-20.5) x 10-15 µm, reddish-brown. Sterile cells subglobose, ellipsoidal or elongated, 5.5-13 x 5-10 µm, yellowish-brown; wall ca. 0.5-1.5 µm thick, smooth.

On *Koeleria litvinowii* Dom. (*Poaceae*), Qinghai: Menyuan, Xianmilinchang, alt. ca. 2800 m, 19 VIII 2004, L. Guo & W. Li 3167, HMAS 99993 (holotypus), isotypus in HUV 20965.

Another *Urocystis* species on *Anemone rivularis* was collected from Gansu Province in 2003. Its spore balls are composed of 1-8(-14) ustilospores completely or incompletely surrounded by sterile cells. Ustilospores completely surrounded by sterile cells have a percentage of about sixty. There are two species of *Urocystis* on *Anemone* having more ustilospores per spore ball, i.e. *U. pseudoanemone* Denchev, Kakish. & Y. Harada (2000) and *U. japonica* (Henn.) L. Ling (1945). The spore balls of *U. pseudoanemone* are composed of 1-5(-11) ustilospores (1=24%, 2=37%, 3=20%, 4=10%, 5=5%, 6=1.8%, 7=1.1%, 8=0.5%, 9=0.1%, 10=0.2%, 11=0.2%; n=2978, Denchev *et al.* 2000) surrounded by a discontinuous layer of sterile cells. The spore balls of *U. japonica* are composed of (1-)2-6(-10) ustilospores (1=4%, 2=17%, 3=32%, 4=23%, 5=11%, 6=6%, 7=3.5%, 8=2%, 9=1.5%, 10=0.5%; n=824, Denchev *et al.* 2000) surrounded by a continuous layer of sterile cells. The species of *Urocystis* on *Anemone rivularis* differs from *U. pseudoanemone* and *U. japonica* in having more ustilospores per spore ball and ustilospores completely or incompletely surrounded by sterile cells. A new species of *Urocystis* is described:

***Urocystis sinensis* L. Guo, sp. nov.**

Figs. 3-4

Sori in foliis et petiolis tumores formantes, primo epidermide obtectas, deinde rupturas. Massa sporarum nigrobrunnea, pulverulenta. Glomeruli sporarum globosi, subglobosi, ellipsoidei, ovoidei, elongati vel irregulares, 19-58(-63) x 15-43 µm, e ustilosporis 1-8(-14) constructi, cellulis sterilibus omnino vel incomplete circumdati. Ustilosporae subglobosae, ellipsoideae, ovoideae vel elongatae, 10-17 x 8.5-12.5 µm, brunneae vel rubrobrunneae, pariete 1-2 µm. Cellulae steriles subglobosae, ovoideae vel ellipsoideae, 7-11 x 5-8 µm, flavidobrunneae vel brunneolae; pariete 0.5-2 µm crasso, levi.

Sori in leaves and petioles, forming swellings, at first covered by the epidermis, which later ruptures. Spore mass blackish-brown, powdery. Spore balls globose, subglobose, ellipsoidal, ovoid, elongated or irregular, 19-58(-63) x 15-43 µm, composed of 1-8(-14) ustilospores (1=6%, 2=10%, 3=20%, 4=14%, 5=12%, 6=10%, 7=10%, 8=7%, 9=4%, 10=2%, 11=2%, 12=1%, 13=1%, 14=1%; n=100), completely or incompletely surrounded by sterile cells. Ustilospores subglobose, ellipsoidal, ovoid or elongated, 10-17 x 8.5-12.5 µm, brown or reddish-brown; wall 1-2 µm thick. Sterile cells ovoid, subglobose or ellipsoidal, 7-11 x 5-8 µm, yellowish-brown or brownish; wall 0.5-2 µm thick, smooth.

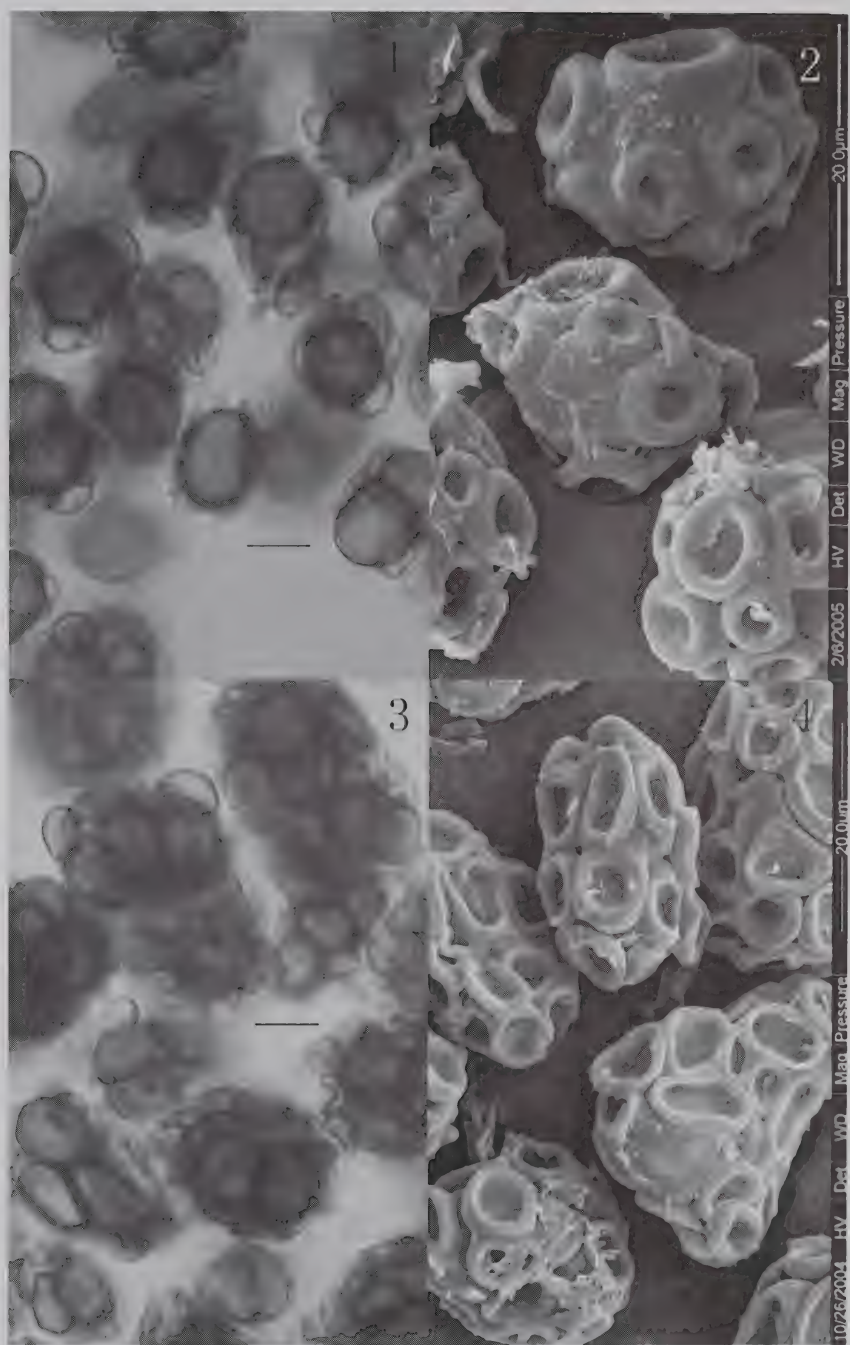
On *Anemone rivularis* Buch.-Ham. ex DC. (*Ranunculaceae*), Gansu: Yuzhong, Xinglongshan, alt. ca. 2400 m, 10 X 2003, H. C. Zhang 2454, HMAS 94853 (holotypus), isotypus in Herbario Ustil. Vánky (HUV 20966).

So far 45 species of *Urocystis* have been recorded for China, including *U. koeleriae* and *U. sinensis* (in this paper).

Figs. 1-2. Spore balls of *Urocystis koeleriae* on *Koeleria litwinowii* as seen by LM (light microscopy) and SEM (Scanning electron microscopy) (HMAS 99993, holotypus).

Figs. 3-4. Spore balls of *Urocystis sinensis* on *Anemone rivularis* as seen by LM and SEM (HMAS 94853, holotypus).

Bars = 10 µm



Acknowledgements

The author would like to express her deep thanks to Dr. Vánky and Prof. Piepenbring for reading the manuscript and serving as pre-submission reviewers, to Mr. Cao Ziyu (Institute of Botany, Chinese Academy of Sciences) and Liu Shurun for identifying the host plants, and to Mrs. Xie Jiayi for assistance with SEM photographs. This study was supported by the National Natural Science Foundation of China (No. 30230020 and No. 30270016).

Literature Cited

- Denchev CM, Kakishima M, Harada Y. 2000. Species of *Urocystis* (Ustilaginomycetes) on *Anemone* in Japan. *Mycoscience* 41: 449-454.
- Fischer GW. 1953. Manual of the North American Smut Fungi. New York, Ronald Press Co., 343 pp.
- Ling L. 1945. A contribution to the knowledge of the *Ustilaginales* in China. *Mycol. Papers* 11: 1-12.
- Vánky K. 1994. European Smut Fungi. Gustav Fischer Verlag Stuttgart, Jena, New York, 570 pp.

***Pseudocercospora siparunae* – a new cercosporoid fungus from the Brazilian tropical forest**

DARTANHA J. SOARES & ROBERT W. BARRETO

*rbarreto@ufv.br**Departamento de Fitopatologia, Universidade Federal de Viçosa
Viçosa, Minas Gerais, 36570-00, Brazil*

Abstract—*Pseudocercospora siparunae*, a new cercosporoid fungus found to be associated with leaf spots on *Siparuna reginae*, is described and illustrated.

Key words—tropical fungi, *Cercosporae*, Brazil

Introduction

Cercosporoid fungi are commonly associated with leaf spot diseases of numerous host plants world-wide. Although these fungi are common in Brazil and other countries in South America, they have generally been poorly studied from this region. Pioneering studies were made by A. S. Muller (Muller & Chupp 1934; Muller & Chupp 1936) and A. P. Viégas (Viégas 1945). During the last two decades, several papers have been published dealing with cercosporoid fungi from Brazil (Dianese & Câmara 1994; Medeiros & Dianese 1994; Inácio et al. 1996; Crous *et al.* 1997; Crous & Câmara 1998; Braun et al. 1999; Dianese et al. 1999; Furlanetto & Dianese 1999; Inácio & Dianese 1999; Barreto & Marini 2002; Braun & Freire 2002, 2004; Pereira et al. 2003; Dornelo-Silva & Dianese 2003).

In December of 2003, a four-day intensive fungal survey was performed at a selected site at Viçosa (state of Minas Gerais, Brazil). The site is a stretch of relatively well preserved native vegetation representing a now much threatened ecosystem that is classified by phytosociologists as “tropical seasonal semi-deciduous montane forest”. This particular site has been studied by botanists based at the Universidade Federal de Viçosa for several years but remained unexplored by mycologists. Over 80 different fungal taxa were collected and are now being processed. Several collections represent either new host-records, new records for Brazil or new taxa. In this paper, one of the new species is described. It was found associated with lesions on leaves of *Siparuna reginae* (Tul.) A. DC. (*Monimiaceae*). The host plant is commonly found in the Brazilian Atlantic Rain Forest. No record was found in the literature of cercosporoid fungi associated to this plant species. A detailed account of this fungus is given in the present paper.

Material and Methods

Freshly collected samples were examined under a stereomicroscope. Hand free sections containing the fungal structures were mounted in lactophenol. Observations,

measurements and line drawings were prepared using an Olympus BX 50 light microscope fitted with a drawing tube. Representative specimens of the fungi were deposited in the herbarium at the Universidade Federal de Viçosa (Herbarium VIC).

Taxonomic Description

Pseudocercospora siparunae D.J. Soares & R.W. Barreto, *sp. nov.*

FIGS 1-3

Maculae amphigenae, circulares vel irregulares, griseae vel pallide griseae, margine atro-brunneo cinctae. Stromata subepidermales, 37.5–58 x 42.5–96 µm. Conidiophora epiphylla, fasciculata cylindrica, 58–100 x 5–6.5 µm, 3–6-septata, laevia, brunnea, tenuitunicata, apicem versus pallidiora. Cellulae conidiogenae terminales, integratae, 17–30.5 x 4–5 µm, subhyalinae. Loci conidiogeni inconspicui. Conidia solitaria, subcylindrica, recta vel leviter curvata, 30–92 x 3–4 µm, 1–4-septata, laevia, subhyalina, tenuitunicata, apice obtuso, basi obconice truncata, 2–3 µm lata, hila non incrassata, non fuscata.

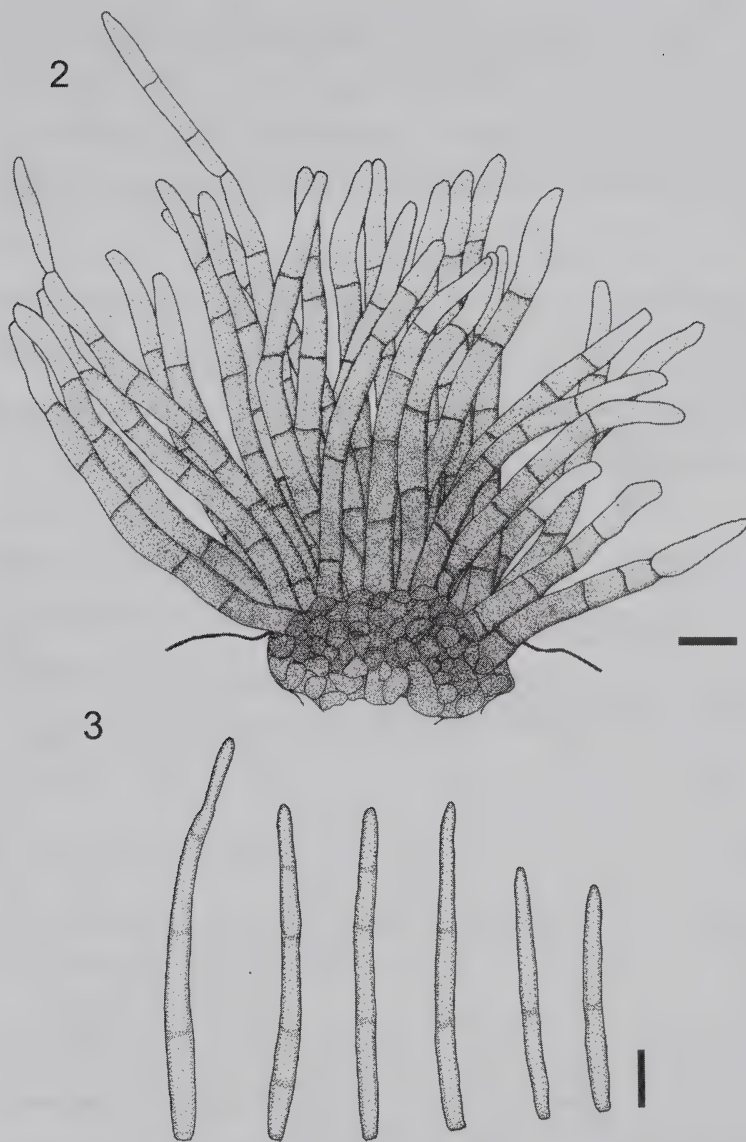
Etymology: from the host genus, *Siparuna*.

Holotype here designated: on *Siparuna reginae*, Brazil, Minas Gerais, Viçosa, Forest of “Seu Nico”, December 2003, D.J. Soares OF-20 (VIC-27830).

Leaf spots amphigenous, circular or irregular, pale grey with a dark brown margin adaxially and dark grey with a dark brown margin abaxially. Stromata subepidermal 37.5–58 x 42.5–96 µm. *Conidiophores* epiphyllous, arising from stromata, aggregated in dense fascicles, 58–100 x 5–6.5 µm, 3–6-septate, brown at the base, paler toward the apex, smooth, thin-walled; *conidiogenous cells* terminal, integrated, 17–30.5 x 4–5 µm, subhyaline; *conidiogenous loci* inconspicuous, not darkened, unthickened; *conidia*, solitary, subcylindrical, straight to slightly curved, 30–92 x 3–4, apex obtuse, base obconically truncate, 2–3 µm wide, 1–4-septate, subhyaline, smooth, thin-walled, hila unthickened, not darkened.



Fig 1. Leaf spots of *Pseudocercospora siparunae* on *Siparuna reginae*, from the holotype. Abaxial view (a) and adaxial view (b).



Figs 2–3. Line drawing of *Pseudocercospora siparunae* on *Siparuna reginae*, from the holotype. 2. Conidiophores arranged in fascicule; 3. Conidia. Scales bar = 10 μ m.

Comments — The family *Monimiaceae* (including *Atherospermataceae* and *Siparunaceae*) comprise 35 genera, about 320 species, and its distribution is mainly tropical and subtropical (Watson & Dallwitz 1992). Despite the *Monimiaceae* being a

relatively large and widespread family and cercosporoid fungi being among the most ubiquitous and diverse groups of fungi, no record could be found of any such fungi having a member of the *Monimiaceae* as host (Chupp 1954; Viegás 1961; Hino & Tokeshi 1978; Mendes et al. 1998; Farr *et al.* 1989; Guo & Hsieh 1995; Crous & Braun 2003; Farr *et al.* n.d.). The fungus on *S. reginae* was compared with descriptions of *Pseudocercospora* spp. occurring on members of the *Lauraceae* (which is regarded as being relatively close to the *Monimiaceae*), but no species having a similar morphology was found.

Acknowledgments

The authors wish to thank Prof. Uwe Braun for help in obtaining some of the relevant literature and reviewing the manuscript and also Dr. Vyrna Beilharz for reviewing the manuscript, the Departamento de Biologia Vegetal of the Universidade Federal de Viçosa for providing support on plant identification, particularly to Gilmar R. Valente and Marcio Batista.

Note: This study represents part of the results of the 1st Mycology Workshop/Foray: "Fungi from Seasonal Semi-deciduous Montane Forest" organized by the Departamento de Fitopatologia of the Universidade Federal de Viçosa, in December of 2003.

Literature Cited

- Barreto RW, Marini FS. 2002. *Mycovellosiella robbsii* sp. nov. causing leaf-spot on *Mimosa caesalpiniaefolia*. Fitopatologia Brasileira 27(6): 610 - 613.
- Braun U, David J, Freire FCO. 1999. Some cercosporoid hyphomycetes from Brazil. Cryptogamie. Mycologie 20(2): 95-106.
- Braun U, Freire FCO. 2002. Some cercosporoid hyphomycetes from Brazil. II. Cryptogamie. Mycologie 23: 295-328.
- Braun U, Freire FCO. 2004. Some cercosporoid hyphomycetes from Brazil - III. Cryptogamie. Mycologie 25(3): 221-244.
- Chupp C. 1954. A monograph of the fungus genus *Cercospora*. Ithaca, New York. Publ. by author.
- Crous PW, Alfenas AC, Barreto RW. 1997. Cercosporoid fungi from Brazil. 1. Mycotaxon 64: 405-430.
- Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Series 1, Ponsen & Looyen, Wageningen, The Netherlands.
- Crous PW, Braun U, Alfenas AC. 1999. Cercosporoid fungi from Brazil. 3. Mycotaxon 72: 171-193.
- Crous PW, Câmara MPS. 1998. Cercosporoid fungi from Brazil. 2. Mycotaxon 68: 299-310.
- Dianese JC, Câmara MPS. 1994. *Pseudocercospora aspidospermatis* - a new combination for *Bactrodesmiella aspidospermatis*. Sydowia 46: 225-232.
- Dianese JC, Furlanetto C, Santos LTP. 1999. *Pseudocercospora zeyheriae*, a new combination for *Cercospora zeyrae*. Mycological Research 103: 40-42.
- Dornelo-Silva D, Dianese JC. 2003. Hyphomycetes on the *Vochysiaceae* from Brazilian Cerrado. Mycologia 95: 1239-1251.
- Farr DF, Bills GF, Chamuris GP, Rossman AY. 1989. Fungi on plants and plant products in the United States. APS Press, St. Paul, Minnesota, USA.
- Farr DF, Rossman AY, Palm ME, & McCray EB. n.d. Fungal Databases, Systematic Botany & Mycology Laboratory, ARS, USDA. Retrieved October 12, 2004, from <http://nt.ars-grin.gov/fungaldatabases/>.

- Furlanetto C, Dianese JC. 1999. Some *Pseudocercospora* species and a new *Prathigada* species from Brazilian Cerrado. *Mycological Research* 103: 1203-1209.
- Guo YL, Hsieh WH. 1995. The genus *Pseudocercospora* in China. *Mycosystema Monographicum Series* 2: 1-388.
- Hino T, Tokeshi H. 1978. Some pathogens of *Cercosporiosis* collected in Brazil. *Technical Bulletin, TARC N° 11*, Japan.
- Inácio CA, Dianese JC. 1999. A new *Mycovellosiella* species on *Myracrodruon urundeuva*. *Mycotaxon* 72: 251-263.
- Inácio CA, Furlanetto C, Hernandez-Gutierrez A, Dianese JC. 1996. Some *Cercospora* species originally described by Ahmés Pinto Viégas. *Fitopatologia Brasileira* 21: 405-409.
- Medeiros RB, Dianese JC. 1994. *Passalora eitenii* sp. nov. on *Syagrus comosa* in Brazil and a key to *Passalora* species. *Mycotaxon* 51: 509-513.
- Mendes MAS, Silva, VL, Dianese JC, Ferreira MASV, Santos CEN, Neto EG, Urban AF, Castro C. 1998. Fungos em plantas no Brasil. Brasília-DF, Embrapa.
- Muller AS, Chupp C. 1934. *Cercosporae* de Minas Gerais. *Arquivos do Instituto de Biologia Vegetal* 1(3): 213-220.
- Muller AS, Chupp C. 1936. Uma segunda contribuição as *Cercosporae* de Minas Gerais. *Arquivos do Instituto de Biologia Vegetal* 3(1): 91-98.
- Pereira OL, Barreto RW, Bezerra JL. 2003. *Cercospora talini* on *Talinum patens* in Brazil. *Fitopatologia Brasileira* 28(2): 205-205.
- Viégas AP. 1945. Alguns fungos do Brasil – *Cercosporae*. *Boletim da Sociedade Brasileira de Agronomia* 8(1): 1-160.
- Viégas AP. 1961. Índice de Fungos da América do Sul. Instituto Agronomico, Campinas-SP, Siqueira.
- Watson L, Dallwitz, MJ. (1992 ff). The families of flowering plants: descriptions, illustrations, identification and information retrieval. Version: 14th December 2000. Retrieved October 11, 2004, from <http://biodiversity.uno.edu/delta/>.

Two new hyphomycetous fungal species from India

G. SURESHKUMAR, K. SHARATH BABU, I.K. KUNWAR
& C. MANOHARACHARY*

*cmchary@rediffmail.com

Botany Department, Osmania University, Hyderabad - 500 007, India

Abstract—Two new foliicolous dematiaceous hyphomycetes, *Phialosporostilbe catenata* and *Piricaudiopsis indica*, are described from the forests of Western Ghats in southern India. *Ph. catenata* produces catenate, cuneiform conidia with two apical setulae. The conidia in *Pi. indica* are fan-shaped, dictyoseptate and usually with two appendages.

Key words—flabelliform, phialidic, conidiogenous cell, synnemata, secession

Two new fungi are conidia-bearing fungi and belong to hyphomycetes (anamorphic). They were both collected from Western Ghats, India, from rotten or dried bamboo culms in December 2003. However, they differ in their conidial ontogeny and other morphological features. Both are described as new taxa.

Phialosporostilbe catenata Sureshkumar, Sharath, Kunwar & Manohar., **sp. nov.**

FIGURES 1-3

Conidiomata synnemata, erecta, recta. Ex conidiophores parallelis, contiguis, apice fertili divergentibus composita. Cellulae conidioigenae terminales, ex axe synnematibus divergentes. Conidia phialidica, catenatus, usque ad 13 per catena, cuneiformia, 2 angulis protuberantibus, non-septata, incolorata, 12.3-15.2 µm longi; in angulo unoquoque praedita setula filosa, 4.8-6.2 µm longi.

Colonies effuse, hairy, white to grayish brown. **Conidiomata** synnematal, erect, straight, 210-320 µm tall, 12-20 µm wide at base, 9-15 µm at the apex, composed of one dark brown, central seta and 8-21 parallel, thick-walled, septate, brown conidiophores diverging at their fertile apices, synnemata indeterminate, incorporating 1 sterile seta, dark brown, smooth, thick walled, blunt, 288-352 µm long, 5-6.8 µm wide, as long as or slightly longer than the conidiophores and surrounded by them. **Conidiogenous cells** terminal, integrated, monophialidic, extending percurrently up to 3 times, diverging from the main axis of the synnema, pale to medium brown, cylindrical to cylindric clavate, 22-45 µm long, 2.4-5 µm wide at base, 2.4-4.4 µm wide at the tip, with an inconspicuous collarette. **Conidia** phialidic, catenate, up to 13 in a chain, cuneiform, with two protuberant corners and a slightly truncate to rounded narrow base, non-septate, smooth, thick-walled, hyaline with dense cytoplasm, 12.3-15.2 µm long, 7.4-10 µm at the widest region, and on each of the two corners having a thin setula, 4.8-6.2 µm long.

Holotype here designated — On rotten bamboo leaves, Western Ghats, India, 10 December, 2003, G. Sureshkumar, HCIO-45,414. Teleomorph unknown.

Mercado and Portales (1985) erected *Phialosporostilbe* with *Ph. turbinata* Mercado and Portales as its type species. It is a synnematus, phialidic, hyphomycete with colourless, turbinate, angular conidia, all the three corners bearing apical setulae and rarely one basal setula. Bhat and Kendrick (1993) described another species. *Ph. setosa* producing two types of conidia, aggregating in colourless slimy masses, besides having a large central seta. Conidia produced from upper conidiogenous cells were like *Ph. turbinata*, whereas the conidia arising from the lower half of the synnema were drop-shaped, 0-septate, colourless, smooth.

In both the described species of *Phialosporostilbe* the conidia are not produced in chain and they are turbinate with 3-4 setulae, whereas in the present fungus the conidia are in chains, cuneiform with only two setulae. Hence *Ph. catenata* is proposed to accommodate the present fungus.

From South India Bhat and Kendrick (1993) collected *Ph. turbinata*, *Ph. setosa* and a possibly congeneric fungus, the mononematous *Nawawia filiformis* Marvanová (1980), which has angular, turbinate conidia with 3-4 apical setulae. According to Bhat and Kendrick (1993) a serious reassessment of these genera, and possibly also the mononematous, apically bisetulate *Chalarodes* Mc Kenzie (1991) is essential. In view of the above, we prefer to dispose our fungus in *Phialosporostilbe* and a key is given for all the known species including *Ph. catenata*.

Key to *Phialosporostilbe*

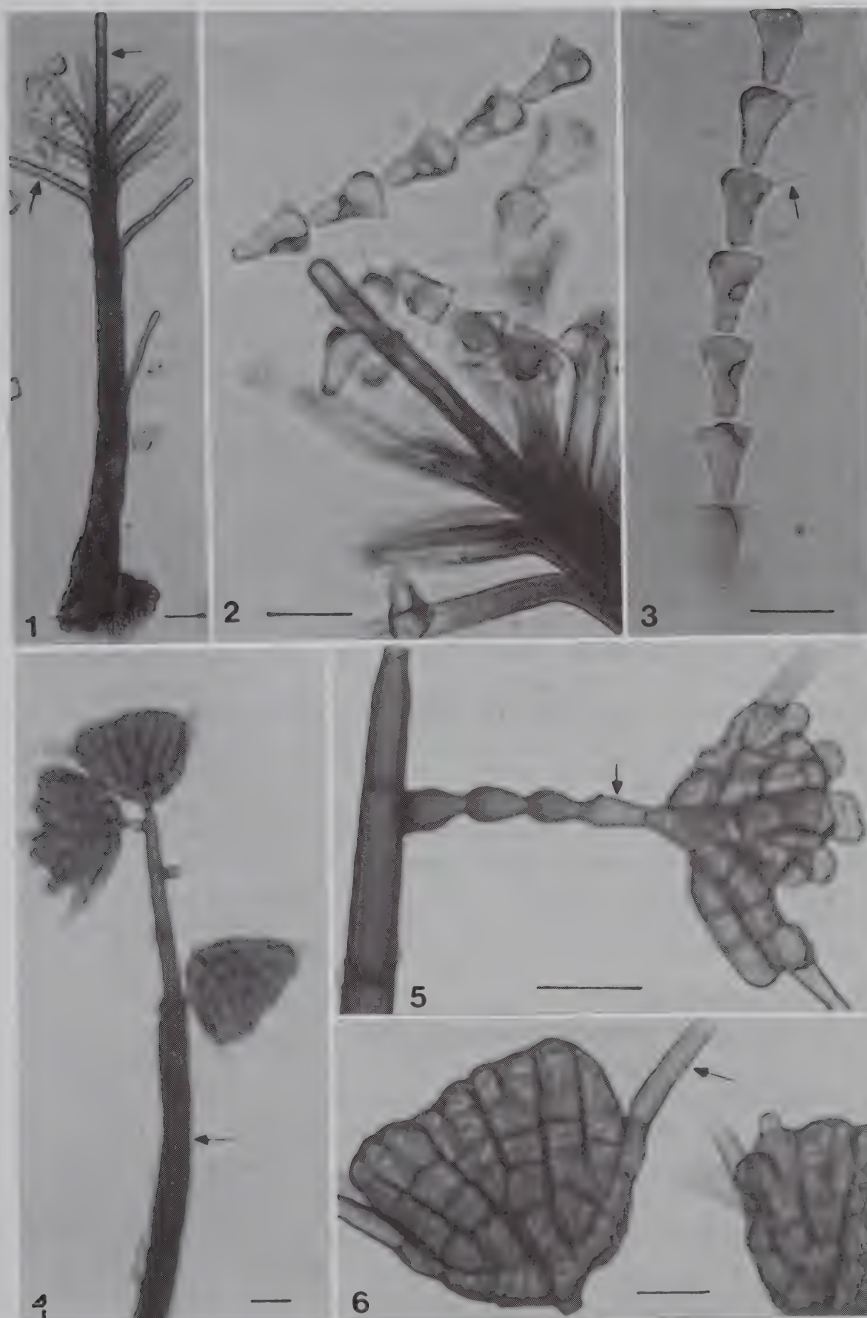
1. Conidia of two types, (i) angular with 4 setulae, (ii) drop shaped *Phialosporostilbe setosa*
- Conidia of one type 2
2. Conidia not in chains, turbinate, angular with 3 apical setulae and sometimes 1 basal setula *Phialosporostilbe turbinata*
- Conidia in chains, cuneiform with two apical setulae *Phialosporostilbe catenata*

Piricaudiopsis indica Sharath, Sureshkumar, Kunwar & Manohar., sp. nov.

FIGURES 4-6

Conidiophora macronemata, mononematica, discreta, erecta vel flexuosa, usque ad 530 µm alt. Cellulae conidiogenae integratae, terminales, laterales. Conidia solitaria, sicca, flabelliformia, dictyoseptata, atrobrunnea, 34-44 µm alt., 39-52 µm latis. In medio appendicibus 2-4 longis, divergentibus, angustis, 14-20 µm longis.

Figs. 1-6. Scale bar = 20 µm. 1-3. *Phialosporostilbe catenata*. 1. Synnema with central seta (arrow), diverging conidiogenous cells (arrow) and conidia. 2. Apical region of synnema with conidiogenous cells and conidia. 3. Catenate, cuneiform conidia with one setula (arrow) each at the two apical corners. 4-6. *Piricaudiopsis indica*. 4. Conidiophore with basal portion sheathed (arrow), conidiogenous cells and conidia. 5. Lateral, percurrent conidiogenous cell (arrow) bearing conidium. 6. Conidia with appendages (arrow).



Conidial fungi, hyphomycetes. **Colonies** effuse, olivaceous to dark brown, hairy. Mycelium immersed in the substrate. **Conidiophores** mononematous, differentiated, basal portion sheath like, brown, upper portion lighter, erect, straight, unbranched, smooth, thick-walled, up to 530 μm long, 13-15 μm wide at the base, 10-12 μm wide at the middle, 3.6-5 μm wide at the apex, 4-13 septate. **Conidiogenous cells** flask shaped, brown, on upper 1/3rd of the conidiophore, integrated, terminal and lateral, truncate after conidia secession, extending percurrently up to 4 times, 7.5-13.5 X 4.2-7.4 μm . **Conidia** solitary, dry, fan-shaped, sometimes two-five lobed, lenticular in edge view, dictyoseptate, brown, sometimes lower one third rugose, with up to 15 vertical rows of cells at the distal end, basal cell protuberant, 3.7-5 μm wide, brown, conidia 34-44 μm high, 39-52 μm wide, with mostly 2, but up to 4 divergent, tapering appendages, arising from outermost rows of cells on the main body of the conidium, on both corners, and occasionally on sides, 1-2 septate, 15-30 μm long, 3-4.4 μm wide at the base, brown, apically colourless, tapering to 2.4-2.8 μm wide.

Holotype here designated — On dried bamboo culms, Western Ghats, India, 14 December, 2003, K. Sharath Babu, HCIO- 45,498. Teleomorph unknown.

The fungus is comparable to *Piricaudiopsis* Portales & Mercado (1987) and *Navaneethospora* Rao (1994). However the genus *Navaneethospora* is inadequately described by Rao (1994) without measurements, Latin diagnosis and other related data hence the authors compared the present fungus only with *Piricaudiopsis*. In *Pi. appendiculata* the conidia are 50-80 μm high, 60-90 μm wide, and appendages are 75-120 μm long, 2-4 in number (Bhat & Kendrick 1993). In *Pi. elegans* the conidia are 28-46 μm long, 50-73.5 (-98) μm wide, appendages being 23-50 μm long and 4-7 in number (Mercado & Portales 1987). The size of conidia, length of appendages and their number are lesser in *Pi. indica* than the other two species. In *Pi. elegans* the vertical rows of cells are up to 7, in *Pi. appendiculata* they are up to 22, whereas in *Pi. indica* they are up to 15. The basal portion of conidiophore in *Pi. indica* is dark brown, sheath like and upper portion is lighter in colour. The sheath like basal portion of conidiophore and extension of conidiogenous cell percurrently up to 4 times is not reported in the other two species. Hence *Pi. indica* is markedly different from the known species of *Piricaudiopsis* and is described as a new species. A key is given to the known taxa including *Pi. indica*.

Key to *Piricaudiopsis*

1. Appendages 4-7, 23-50 μm long; conidia 50-73.5 μm wide
..... *Piricaudiopsis elegans*
- Appendages 2-4. 2
2. Appendages 75-120 μm long; conidia 60-90 μm wide
..... *Piricaudiopsis appendiculata*
- Appendages 15-30 μm long; conidia 39-52 μm wide
..... *Piricaudiopsis indica*

Acknowledgements

The authors are grateful to Prof. K.G. Mukerji, New Delhi and Prof. S.M. Reddy, Warangal for reviewing the manuscript and thank the DBT and MoENF, New Delhi for financial assistance.

References

- Bhat DJ, Kendrick Bryce. 1993. Twenty new conidial fungi from the Western Ghats and the Andaman Islands (India). *Mycotaxon*. 41: 19-90.
- Marvanová L. 1980. New or noteworthy aquatic hyphomycetes, *Clavatospora*, *Heliscella*, *Nawawia* and *Heliscina*. *Tr. Br. mycol. Soc.* 75: 221-231.
- McKenzie EHC. 1991. Dematiaceous hyphomycetes on *Freycinetia* (Pandanaaceae) – 3. *Chalarodes* gen. nov. *Mycotaxon*. 42: 89-93.
- Mercado SA, Portales MJ. 1985. *Revista del Jardin Botanico*. La habana, Cuba. 6: 57.
- Portales MJ, Mercado SA. 1987. *Piricaudiopsis* (Hyphomycetes) Deuteromycotina, nuevo género enteroblastico de Cuba. *Acta Botanica Cubana*. 51: 1-5.
- Rao V. 1994. Review of some holo-monoblastic, ampulliform conidiogenous cells producing hyphomycetes. *Current Trends in Life Sciences*, New Delhi, India. 20: 129-136.

Erysiphe pachypodii* – a new species on *Pachypodium lamerei

ALEŠ LEBEDA, BARBORA MIESLEROVÁ & IVANA DOLEŽALOVÁ

lebeda@prfholt.upol.cz

Palacký University, Faculty of Science, Department of Botany
Šlechtitelů 11, 783 71 Olomouc-Holice, Czech Republic

Abstract — *Erysiphe pachypodii*, a new powdery mildew species, is proposed and described.

Key words — *Erysiphales*, new taxon, *Apocynaceae*, Czech Republic

Introduction

During the summer and autumn of 1999, symptoms of a powdery mildew disease were observed for the first time on *Pachypodium lamerei* Drake (family *Apocynaceae*) in the Czech Republic. White lesions of irregular shape appeared at leaf margins and spread towards the central vein, often followed by necrosis of the leaf tissue. Both the anamorph and teleomorph of the fungus appeared on the infected leaves. The examination of the morphology of this fungus revealed that it belongs in *Erysiphe* DC. *emend.* (incl. *Uncinula* Lév.), and a comparison with morphologically allied taxa showed that it represents an undescribed species. Lebeda et al. (2002) published first results, including a detailed documentation by micrographs, and proposed the name *Erysiphe pachypodiae*, which was, however, not validly published, according to ICBN, Art. 32 (Greuter et al. 2000) until now. Therefore, the following validation is necessary.

Description of the new species

***Erysiphe pachypodii* Lebeda, Mieslerová & Doležalová, sp. nov.**

Illustration: Lebeda et al. (2002: 151, Fig. 1 a-g).

Mycelium superficiale, album, e hyphis ramificatis, 5-7 µm latis cum conidiis 29,28-41,94 µm (per medio 34,9 µm) longis et 8,7-13,5 µm (per medio 11,4 µm) latis, cylindricis, cum proportione longitudinis/latitudinis 2,33-4,3 (per medio 3,01), corpusculis fibrosinis absentibus, cum tubulo germinativo acrogeno (e parte terminale conidii nascente), saepe in apice dilatato, cum appressoriis sublobatis usque lobatis. Conidiophora erecta, cum cellulis stipitiformibus in cellulas distales 1-2(-3) (per medio 1,7), singulare formatis protractis (typi Pseudoidium). Cellulae stipitiformes rectae, 24,4-56,68 µm longae (per medio 37,03 µm) et 6-9 µm (per medio 7,35 µm) latae; longitudo conidiophorum summatim 56,12-95,16 µm (per medio 74,31 µm). Cleistothecia 68,6-112,7 µm (per medio 91,48 µm) in diametro; cum 3-8 ascis; cum

4-17 (per medio 8) appendicibus mycelioidis septatis (septa 2-4), absque inflationibus basalibus, hyalinis seu pallide brunneis in partibus basalibus, in apicibus aliquando circinatis; apices circinati haud inflati (haud amplificati); longitudo appendicum 166-441 μm (per medio 302 μm) et latitudo 4,8-6 μm (per medio 5,4 μm), 1,4x longiores quam diametrum cleistothecii, tenuitunicatae, solum basim crassitunicatae. Asci 46,36-63,44 μm longi (per medio 52,01 μm) et 31,72-44,8 μm (per medio 38 μm) lati, proportio longitudinis vs. latitudinis 1,37 (1,17-1,73); cum stipite brevi; cum 2-5 ascosporis. Ascosporae ellipsoideo-ovoideae, 18,3-20,7 μm (per medio 19,5 μm) longae et 7,3-9,7 μm latae (per medio 8,5 μm), proportio longitudinis vs. latitudinis 2-2,6 (per medio 2,3).

Holotype here designated: on leaves of *Pachypodium lamerei* Drake (Apocynaceae), Czech Republic, Smržice, 20 Aug. 1999, EPL 1 (OL).

Mycelium superficial, white; hyphae branched, 5-7 μm wide; appressoria slightly lobed to lobed. Conidiophores erect, 56.12-95.16 μm long (mean 74.31 μm), foot-cells straight, 24.4-56.68 μm long (mean 37.03 μm) and 6-9 μm wide (mean 7.35 μm), followed by 1-2(-3) distal cells (mean 1.7). Conidia solitary, cylindrical, without fibrosin bodies, 29.28-41.94 μm (mean 34.9 μm) long and 8.76-13.56 μm (mean 11.43 μm) wide, shape index 2.33-4.3 (mean 3.01), with germ tube arising from the end of the conidium, often broadened at its apex. Ascomata 68.6-112.7 μm diam. (mean 91.48 μm), with 4-17 (mean 8) more or less equatorial appendages, 166-441 μm long (mean 302 μm) and 4.8-6 μm wide (mean 5.4 μm) [1.5-4 times as long as the ascoma diam.], 2-4-septate, base not swollen, hyaline or pale brown at the base, mycelioid, thin-walled, smooth, only thickened at the base, apex straight or occasionally circinate, circinate apex not enlarged. Asci 3-8, 46.36-63.44 μm (mean 52.01 μm) long and 31.72-48.8 μm (mean 38 μm) wide, short-stalked, shape index 1.37 (1.17-1.73), with 2-5 ellipsoid-ovoid ascospores, 18.3-20.7 μm (mean 19.5 μm) long and 7.3-9.7 μm (mean 8.5 μm) wide, shape index between 2-2.6 (mean 2.3).

Discussion

So far the polyphagous species *Golovinomyces orontii* (Castagne) V.P. Gelyuta has been the only powdery mildew reported on *Pachypodium* species. However, the new species is quite distinct from *G. orontii*, in which the conidia are formed in chains (euoidium type), by its pseudoidium anamorph (conidia formed singly). On account of the anamorph and ascomata with circinate appendages, the new species belongs to the former genus *Uncinula*. Recently, molecular analyses showed that genera with pseudoidium anamorphs (*Erysiphe* s. str., *Microsphaera* and *Uncinula*) belong to a single monophyletic clade, and that the affinity between them is much closer than between *Erysiphe* sect. *Erysiphe* (*Erysiphe* s. str.) and *Erysiphe* sect. *Golovinomyces* U. Braun (now *Golovinomyces* (U. Braun) V.P. Gelyuta (Saenz and Taylor 1999, Mori et al. 2000, Braun et al. 2002). Based on the new classification of the *Erysiphales*, reducing *Microsphaera* Lév. and *Uncinula* to synonymy with *Erysiphe* s. str. (Braun & Takamatsu 2000), the new species has to be assigned to *Erysiphe emend.* (*Erysiphe* sect. *Uncinula* (Lév.) U. Braun & N. Shishkoff, due to the morphology of the appendages).

All known species of *Erysiphe* sect. *Uncinula* with pluriseptate appendages, viz. *Erysiphe actinidiae* (Miyabe ex Jacz.) U. Braun & S. Takam., *E. hydrangeae* (Z.X.

Chen & R.X. Gao) U. Braun & S. Takam., *E. jaborosae* (Seaver) U. Braun & S. Takam., and *E. necator* Schwein. (Braun 1987, 1995) differ from the new species on *P. lamerei* in having pigmented appendages, 4-8-spored asci, and some additional deviating features.

Acknowledgements

Generous help of Dr. Z. Pouzar with translation of Latin diagnosis is acknowledged. This research was supported by the projects: 'Stress and Pathological Biology, Biochemistry and Bioenergetics of Plants' (MSM 153100010), 'Variability of Components and Interactions in Plant Pathosystem and Impact of Environmental Factors on Their Expression' (MSM 6198959215, both Czech Ministry of Education, Praha), and partly by the Czech Ministry of Agriculture (Praha) from the 'National Programme of Genepool Conservation of Microorganisms and Small Animals of the Economic Importance'.

Literature Cited

- Braun U. 1987. A Monograph of the *Erysiphales* (powdery mildews). Beih. Nova Hedwigia 89: 1-700.
- Braun U. 1995. The Powdery Mildews (*Erysiphales*) of Europe. G. Fischer Verlag, Jena. 337 pp.
- Braun U, Cook RTA, Inman AJ, Shin H-D. 2002. The taxonomy of the powdery mildew fungi. In: RR Bélanger, WR Bushnell, AJ Dik, TLW Carver (eds.) The Powdery Mildews. A Comprehensive Treatise. APS Press, St. Paul. pp. 13-55.
- Braun U, Takamatsu S. 2000. Phylogeny of *Erysiphe*, *Microsphaera*, *Uncinula* (*Erysipheae*) and *Cystotheca*, *Podosphaera*, *Sphaerotheca* (*Cystothecaceae*) inferred from rDNA ITS sequences – some taxonomic consequences. *Schlechtendalia* 4: 1-33.
- Greuter W, McNeill J, Barrie FR, Burdet HM, DeMoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Trehane P, Turland NJ, Hawksworth DL. 2000. International Code of Botanical Nomenclature (Saint Louis Code). *Regnum Vegetabile*, Vol. 138. Koeltz Scientific Books, Königstein.
- Lebeda A, Mieslerová, B, Doležalová I. 2002. The first record and characterization of powdery mildew (*Erysiphe pachypodiae* sp. nov.) on *Pachypodium lamerei* (*Apocynaceae*). *J. Phytopath.* 150: 149-154.
- Mori Y, Sato Y, Takamatsu S. 2000. Evolutionary analysis of the powdery mildew fungi using nucleotide sequences of the nuclear ribosomal DNA. *Mycologia* 92: 74-93.
- Saenz GS, Taylor JW. 1999. Phylogeny of the *Erysiphales* (powdery mildews) inferred from the internal transcribed spacer (ITS) ribosomal DNA sequences. *Can. J. Bot.* 77: 150-169.

***Dactylella zhongdianensis* sp. nov, a new predacious antagonist of nematodes**

JING ZHANG^{1,2**}, MINGHE MO^{1**}, JINGSHI DENG¹,
XUEFENG LIU³, TINGJU BI² & KEQIN ZHANG^{1*}

kqzhang111@yahoo.com.cn

¹Laboratory for Conservation and Utilization of Bioresources
Yunnan University, Kunming 650091, P.R. China

²Teacher Training School of Simao, Simao 665000, Yunnan, P.R. China

³Forestry College of Northeast Forestry University, Haerbin 150040, P. R. China

Abstract—A new predacious fungus, *Dactylella zhongdianensis*, is described and illustrated from Zhongdian in western Yunnan, China. This fungus is characterized by its solitary clavate, multiseptate conidia borne on erect unbranched or branched conidiophores. It forms adhesive networks as a capture device in the presence of nematodes. Infection, host specificity, and pathogenicity of the new species to nematodes are also described.

Key words—nematode-trapping fungi

Introduction

Nematophagous fungi have been the subjects of research over several decades in fundamental studies of their ecology, distribution and systematics, and as potential biological control agents of nematode pathogens of plants and animals (Li et al. 2002). These fungi, which comprise a diverse range of fungi able to infect and digest nematodes, can be divided into four categories: endoparasitic fungi, nematode-trapping fungi, fungi that parasitize eggs and females, and toxin-producing fungi (Barron & Thorn 1987, Dackman et al. 1992). Nematode-trapping fungi are unique, however, in their morphological adaptation to the predacious habit and in their ability to capture and consume prey. These fungi have a more complex relationship with their nematode host, since they also have an ability to live saprophytically. They form different hyphal structures (adhesive nets, knobs, branches or hyphae, constricting rings or non-constricting rings) in order to capture nematodes (Barron 1977). Nematode-trapping fungi have been known for over a century. Ecological surveys on their occurrence indicate that this group is found throughout the world, in all types of climate and in all the habitats examined (Gray 1987). The biocontrol potential of nematode-trapping

^{**} These authors contributed equally to this work.

fungi has also been considered (Chandrawathani et al. 1998, Fernández et al. 1999, Manuelli et al. 1999). There have been some recent exciting advances in the control of nematode parasites of livestock, by exploiting the nematophagous properties of nematode-trapping fungi. Among these predators, *Arthrobotrys flagrans* (Dudd. 1950) Sidorova, Gorlenko & Nalepina [= *Duddingtonia flagrans* (Dudd. 1950) RC Cooke (Cooke 1969)] has been selected for commercial development (Fernández et al. 1999).

Here, we report a new predacious fungus, *Dactylella zhongdianensis*, and outline its infection and pathogenicity to nematodes.

Materials and methods

Isolation of the fungus

While surveying the predacious fungi, we collected soil samples from Zhongdian, Yunnan, China on 7 September 2003. Subsamples of 1-2 g were spread on Corn Meal Agar (CMA) plates and stored at room temperature (about 20-28°C). After incubation for 20 days, the entire surface of the petri dishes were observed under a dissecting microscope and the conidia of nematode-trapping fungi were isolated to CMA plates by sterile toothpick. For identification, the cultures were incubated on CMA for 14-30 days at 28°C and the taxonomic characters were measured and determined. The trap formation was induced by nematode *Panagrellus redivivus* (Linne 1767) Goodey according to the description of Lei et al. (1998). Microscopic photographs of the fungus were taken from fresh living material mounted in water using an Olympus BX51 microscope.

Infection and pathogenicity of the fungus to nematodes

Two plant-parasitic nematodes, *Bursaphelenchus xylophilus* (Steiner & Buhner 1934) Nickle, *Meloidogyne arenaria* (Neal 1889) Chitwood and one free-living nematode *P. redivivus* were used in the tests. *B. xylophilus* and *P. redivivus* were cultured on media and stored in our lab. The larvae of *M. arenaria* were isolated from root knots of tobacco from Yiliang, Kunming, China. Predation rates were used to evaluate the pathogenicity of the fungus against nematodes. For the pathogenicity test, the fungus was inoculated on Water Agar (WA) plates. After incubation at 28°C for two weeks, about 200 individuals per nematode species were added to the plates. Each experiment was carried out in triplicate. The predation rate was calculated by recording the proportion of nematodes trapped by predacious structures and calculated using the following formula:

Predation rate = Number of nematodes trapped by networks/Total number of nematodes observed × 100%.

Results and discussion

Taxonomic description

Dactylella zhongdianensis J. Zhang & K.Q. Zhang **sp. nov.** (Figs 1-7)

Coloniae in extracto granorae zaeae maydae cum agar albidae. Hyphae hyalinae, septatae, ramosae, 2-3 µm latae. Conidiophora hyalinae, erectae, spatulae, simplicae, parca ramosae, 20-107.5 µm longae, basi 2.5-4.5 µm crassae, apice 1-2 µm crassae,

ibi uni-conidium ferentes. Conidiae hyalinae, clavatae, plerumque levitr curvae, 2-6 septatae, praecipue 3-septae, 17.5-35(28.3)×5-10(7.2) µm. Reticulis tenacia quae vermiculos nematodeos capiunt evolventibus.

Etymology: in reference to Zhongdian, the place where the fungus was first isolated.

Holotype here designated: YMF1.00568D, Zhongdian, Province Yunnan, China, 7 September 2003, Jing Zhang. The holotype and its culture (YMF1.00568) are deposited in the Laboratory for Conservation and Utilization of Bio-resources, Yunnan, P. R. China.

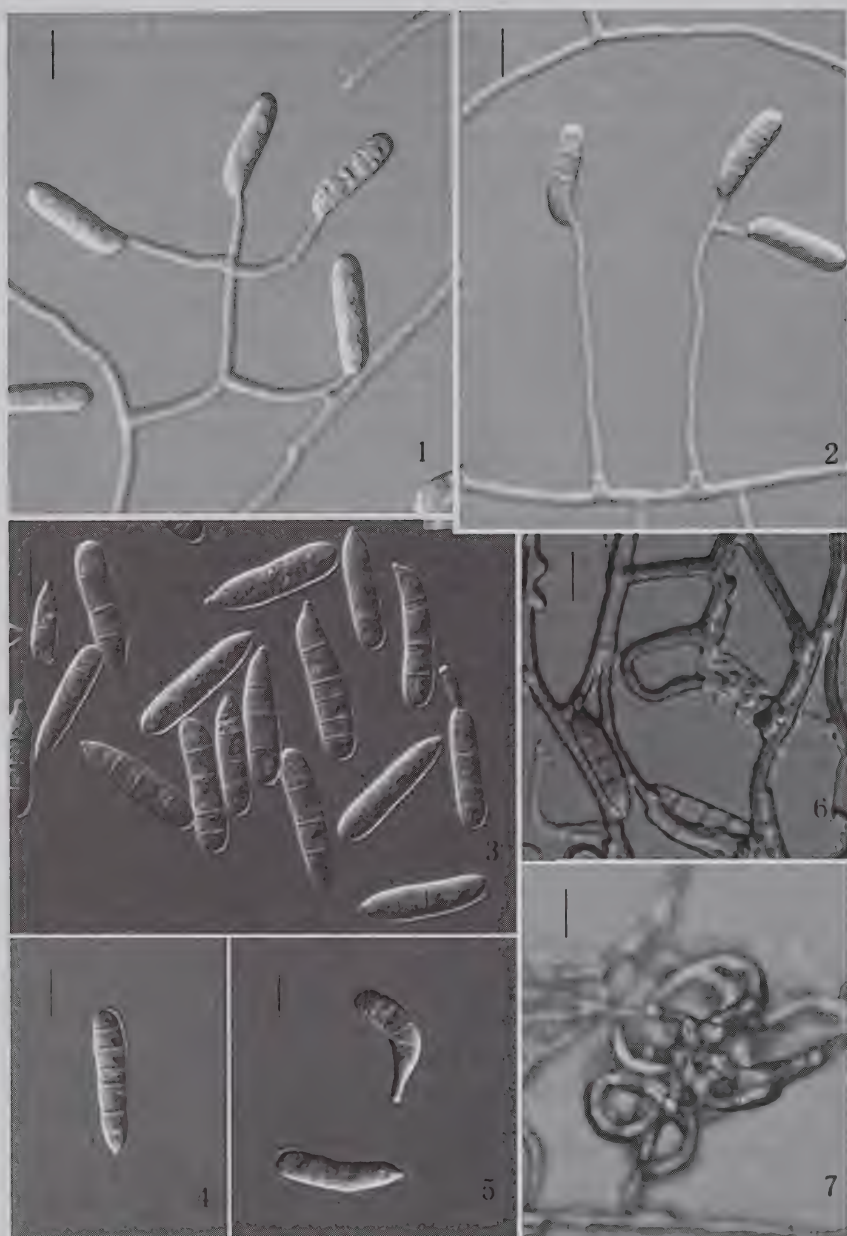
Colonies on CMA medium whitish at first and later granular for the mass spores, aerial hyphae hyaline, septate, branched, 2-3 µm wide. Conidiophores hyaline, erect, septate, unbranched or forming 2-5 branches, 20-117.5 µm high, 2.5-4.5 µm wide at the base, tapering upward gradually to 1-2 µm wide at the tip, and bearing there a single conidium, Conidia hyaline, mostly clavate, rarely curved or slightly curved at basal end, rounded distally, producing umbilicus at the base, 2-6-septate, mainly 3-septate, 17.5-35×28.3×5-10×7.2 µm. The proportion of conidia with 2, 3, 4, 5 and 6 septa is 8%, 82.4%, 7.5%, 1.6% and 0.5% respectively. The predacious device exhibits a three-dimensional adhesive network with small dense loops.

The genus *Dactylella* was established by Grove (1884) based on the type of *D. minuta* Grove 1884, and its circumscription was emended several times by different authors (Schenck et al. 1977, Van Oorschot 1985, Zhang et al. 1994) and recently was summarized by Miao et al. (2003) in detail. We prefer to place the new species in *Dactylella* following the generic concept of Subramanian (1963), who characterized *Dactylella* as having primarily cylindrical, ellipsoidal, clavate or fusoid conidia that are multi-septate (without a large inflated central cell) and solitarily borne on the conidiophore.

The new species resembles *D. pseudoclavata* Z.Q. Miao & X.Z. Liu 2003 (Miao et al. 2003) and *D. shizishanna* X.F. Liu & K.Q. Zhang 2003 (Liu & Zhang 2003) in conidial shape and the kind of predatory device, but can be distinguished as follows. *D. zhongdianensis* forms shorter conidia [17.5-35(28.3)×5-10(7.2) µm] than those of *D. shizishanna* [22.5-73.8(50.6)×5-10(6.6) µm]. The conidia of *D. zhongdianensis* usually have 2-6 (mainly 3) septa and show an umbilicus at the base, but *D. shizishanna* produces conidia with 2-9 (mainly 3-7) septa and without the umbilicus, while *D. pseudoclavata* produces 0-1-septate conidia with a bottleneck shaped base. *D. zhongdianensis* also resembles *D. clavata* R.H. Gao, M.H. Sun & X.Z. Liu 1995 (Gao et al. 1995), *D. cylindrospora* (RC Cooke 1969) A. Rubner (Rubner 1996), *D. rhopalota* Drechsler 1943 (Drechsler 1943), and *D. submersa* (Ingold 1944) Nisson (Ingold 1944) in conidial shape and size. However, the four similar species do not produce predacious devices when confronted by nematodes.

Infection and pathogenicity of *Dactylella zhongdianensis* to nematodes

On WA plates, the fungus extended in all directions from the inoculum into the surrounding substratum after stored at 28°C for 3 days and obtained a 9 cm diam colony in 11 days. Two days after adding the nematodes, the radiating hyphae gave rise at varying intervals to three-dimensional networks. Nematodes that in their continuous



Figs.1-7. *Dactylella zhongdianensis*. 1-2. Conidiophores with conidia. 3-5. Conidia. 6. The radiating hyphae begin to give rise to form trap device. 7. Three-dimensional adhesive networks. Bar=10 μ m.

movement happened to run afoul of these structures were held fast despite their energetic struggles to escape. Following narrow perforation of the integument, the fungus infected the struggling nematode by intruding globose infective bodies from which assimilative hyphae then extended to invade the fleshy interior. At first the assimilative hyphae were badly obscured from view due to the globose degeneration of the animal's musculature and organs. The assimilative hyphae became more clearly visible after the degenerating material had been largely absorbed. Eventually the assimilative hyphae were wholly emptied of contents by withdrawing their protoplasm backward into the external mycelium and, together with the collapsing pellicle, vanishing from sight. With ample nourishment being obtained through destruction of many nematodes, the fungus soon produced conidiophores and conidia from the dead animals. The fungus displayed no host prey specificity in infection pattern and capture capability when tested with three nematode species. The fungus was able to trap and consume the nematodes *B. xylophilus*, *M. arenaria*, and *P. redivivus* showing predation rates of 75.6%, 80.3% and 78.5% respectively, and the rates are not significantly different ($P > 0.01$). Our result showing that the predator lacked host specificity agrees with previous reports (for a review see: Gray 1987).

Acknowledgments

We are very grateful to Dr. XingZhong Liu and Dr. ShiDong Li for revising the manuscript and valuable comments. We are also indebted to MeiHua Liu for helping with the Latin. This work was jointly supported by the projects from Ministry of Science and Technology of P. R. China (2003CB415102, 2002BA901A21, 2002CCCO2800, 2001DEA10009-10), NSFC (39860006, 30230020), and Department of Science and Technology of Yunnan Province (2000C0012Z, 2003RC03, 2001ZCBFB01C).

Literature Cited

- Barron GL. 1977. The Nematode-destroying Fungi. Canadian Biological Publications, Guelph, Ontario Canada.
- Barron GL, Thorn RG. 1987. Destruction of nematodes by species of *Pleurotus*. Can. J. Bot. 65, 774-778.
- Chandrawathani P, Omar J, Waller PJ. 1998. The control of the free-living stages of *Strongyloides papillosus* by the nematophagous fungus, *Arthrobotrys oligospora*. Vet. Parasitol. 76: 321-325.
- Cooke RC. 1969. Two nematode-trapping hyphomycetes, *Duddingtonia flagrans* gen. et comb. nov. and *Monacrosporium mutabilis* sp. nov. Trans. Br. Mycol. Soc. 53:315-319.
- Dackman C, Jansson HB, Nordbring-Hertz B. 1992. Nematophagous fungi and their activities in soil. In: G. Stotzky, JM Bollag (Eds.), Soil biochemistry. Marcel Dekker, New York.
- Drechsler C. 1943. A new nematode-capturing *Dactylella* and several related hyphomycetes. Mycologia 35:339-362.
- Fernández AS, Larsen M, Nansen P, Grønvoldm J. 1999. The efficacy of two isolates of the nematode-trapping fungus *Duddingtonia flagrans* against *Dictyocaulus viviparus* larvae in faeces. Vet. Parasitol. 85:289-304.
- Gao RH, Sun MH, Liu XZ. 1995. *Dactylella clavata* sp. nov., a hyphomycete from Xisha islands, China. Mycotaxon 56:191-195.

- Gray NF. 1987. Nematophagous fungi with particular reference to their ecology. Biol. Rev. 62, 254-304.
- Grove WB. 1884. New or noteworthy fungi. J. Bot. Lond. 22:195-201.
- Ingold CT. 1944. Some new aquatic hyphomycetes. Trans. Brit. Mycol. Soc. 27:35-43.
- Lei LP, Li TF, Xia ZY, Liu XZ, Gao RH. 1998. A simple method for inducing and observing predacious devices of nematode-trapping fungi. J. Jilin Agr. Uni. (Suppl.):130(In Chinese).
- Li TF, Zhang KQ, Liu XZ. 2000. Taxonomy of nematophagous fungi. Chinese Scientific & Technological publication.
- Liu XF, Zhang KQ. 2003. *Dactylella shizishanna* sp.nov. from Shizi Mountain, China. Fungal Divers. 14:103-107.
- Manueli PR, Waller PJ, Faedo M, Mahommed F. 1999. Biological control of nematode parasites of livestock in Fiji: screening of fresh dung of small ruminants for the presence of nematophagous fungi. Vet. Parasitol. 81:39-45.
- Miao ZQ, Liu XZ, Li SD, He MX. 2003. *Dactylella pseudoclavate* sp. nov., a new nematode-trapping fungus. Can. J. Bot. 81:1-5.
- Rubner A. 1996. Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. Stud. Mycol. 39:1-134.
- Schenck S, Kendrick WB, Pramer D. 1977. A new nematode-trapping species and a revaluation of *Dactylaria* and *Arthrobotrys*. Can. J. Bot. 55:977-985.
- Subramanian CV. 1963. *Dactylella*—*Manacrosporium* and *Dactylina*. J. Indian Bot. Soc. 42: 291-300.
- Van Oorschot CAN. 1985. Taxonomy of the *Dactylaria* complex. V. A review of *Arthrobotrys* and allied genera. Stud. Mycol. 26:61-96.
- Zhang KQ, Liu XZ, Cao L. 1994. A review of *Dactylella* and a new species. Mycosystema 7:111-118.

Isozyme analysis of twelve species of the genus *Ascobolus*

DIANA A. DOKMETZIAN, MARIA E. RANALLI
& BEATRIZ O. SAIDMAN

dokmetzi@bg.fcen.uba.ar

*Departamento de Biodiversidad y Biología Experimental
Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires
Ciudad Universitaria, C1428 EHA, Buenos Aires, Argentina*

Abstract — The aim of this work was the delimitation of twelve species of the genus *Ascobolus* (Ascomycota, *Pezizales*) based on analysis of electrophoretic patterns of intracellular enzymes. Forty-seven monosporic strains and twenty-two mixed cultures of compatible strains of the genus were used and numerical techniques were applied. Six intracellular isozyme systems were analysed: aspartate aminotransferase, esterase, acid phosphatase, glutamate dehydrogenase, isocitrate dehydrogenase and superoxide dismutase. The phenograms obtained from cluster analysis (UPGMA) showed two groups of species, corresponding to the two sections of the genus (section *Ascobolus* and section *Dasyobolus*), with some differences within each section. Although high intraspecific homogeneity was observed species of *Ascobolus* exhibited no intraspecific variation for these enzyme systems with the exception of *A. gamundiae* and *A. ferrugineus* which were variable for esterase and acid phosphatase respectively. The results of this research allow us to establish that the twelve species studied are independent taxonomical entities.

Key Words — *Ascobolaceae*, fungi, isozymes, sexuality, taxonomy

Introduction

The genus *Ascobolus* Boudier (Ascomycota, *Pezizales*) was established for apothecial species with colored and independent ascospores within the ascus. Van Brummelen (1967) included it in the family *Ascobolaceae* subfamily *Ascoboloideae*, grouping the different species in seven sections. The traditional classification of the fungi is based on the color, shape and ornamentation of ascospores, characteristics of the vegetative hyphae and sexual reproduction. The studies of Bistis (1956, 1957) and Bistis and Raper (1963) on *Ascobolus stercorarius* and Ranalli & Gamundí (1975) on *Ascobolus biguttulatus*, both species with typical bipolar heterothallism, allowed the classification of some of the aspects involved in sexual reproduction and showed the existence of hormonal substances which control the differentiation of sexual structures and their subsequent plasmogamy. Dokmetzian & Ranalli (1994) made interspecific crossings among five species of *Ascobolus*. Their results suggested that hormonal substances responsible for apothecial formation are very similar in some species but not identical.

Isozyme analysis is most frequently used to address taxonomic problems, particularly when morphological characteristics overlap or are plastic within a genus or species (Micales et al. 1992). Differences in the isoenzymatic patterns have been used to separate species of *Agaricus* (Kerrigan & Ross 1988), *Botrytis* (Backhouse et al. 1984), *Glomus* (Hepper et al. 1988), *Penicillium* (Cruickshank & Pitt 1987), *Phytophthora* (Bielenin et al. 1988), *Pleurotus* (May & Royse 1988), *Puccinia* (Newton et al. 1985) and *Ganoderma* (Gottlieb et al. 1998). Using the traditional morphological classification system for the genus *Ascobolus* has led many times to doubts when trying to establish clear limits between related or supposedly related species that exhibit high morphological similarities. Our aim in this work was to identify twelve species belonging to the genus *Ascobolus* analyzing the isozyme patterns of 47 strains belonging to the sections *Ascobolus* and *Dasyobolus*.

Materials and Methods

Isolates. Strains used in this study (Table 1) include 47 monosporic strains obtained from germinating ascospore and 22 mixed cultures (strain + and strain -) of 12 species of *Ascobolus*: *A. bahiensis* Dokmetzian & Ranalli 1992, *A. gamundiae* Dokmetzian & Ranalli 1992, *A. biguttulatus* Ranalli & Gamundí 1975, *A. furfuraceus* Pers per Hook 1801, *A. michaudii* Boud. 1904, *A. crenulatus* P. Karst 1868, *A. ferrugineus* Ranalli & Forchiassin 1979, *A. amoenus* Oud. 1882, *A. mancus* (Rehm) Brumm. 1967, *A. bistisii* Gamundí & Ranalli 1966, *A. immersus* Pers. 1794 and *A. stictoides* Speg. 1879. The first six species belong to the section *Ascobolus* and the remaining to the section *Dasyobolus* (van Brummelen 1967).

Culture conditions. Monosporic strains were kept in filter paper (PF) medium (yeast extract, 3 g; agar, 18 g; distilled water, 1000 ml and filter paper (Gamundí & Ranalli 1964) at 5 °C for three months. In order to obtain sexually compatible strains and determine their polarity, they were crossed in pairs; each monosporic strain of a compatible pair was crossed with each of the monosporic strains of another compatible pair using Petri dishes with PF medium, and were incubated at 23 °C with constant light for 14 d. All species studied are heterothallic with the exception of *A. crenulatus* and *A. stictoides* which are homothallic and crosses between strains of these two species were not performed. All strains are deposited in the culture collection of the Faculty of Sciences of the University of Buenos Aires (BAFC). Erlenmeyer flasks with 50 ml of liquid synthetic medium GA (glucose 15 g; asparagine, 4 g; $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 0.5 g; KH_2PO_4 , 0.5 g; K_2HPO_4 , 0.6 g; $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, 0.4 mg; $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$, 0.09 mg; H_3BO_3 , 0.07 mg; $\text{NaMoO}_4 \cdot 2\text{H}_2\text{O}$, 0.02 mg; FeCl_3 1 mg; ZnCl_2 , 10 mg; biotin, 5 µg; thiamine-HCl, 0.1 mg; bidistilled water to 1 l) were inoculated with 9 mm² squares of agar taken from the margin of 3-4 d old colonies grown on 2% Bacto agar- water. Incubation was carried out in a New Brunswick Psycrotherm G-27, at 23 °C illuminated by four 20 W fluorescent bulbs and shaken continuously at 125 r.p.m.

Liquid cultures were harvested and vacuum filtered through filter paper the day of maximum growth for each strain of the compatible pairs (Dokmetzian & Ranalli 1998). Mixed samples were obtained by inoculating the Erlenmeyer flasks with both compatible strains and harvesting the day of maximum growth for the fastest strain (when they differed). Mycelia were rinsed three times with distilled water, dried and

Table 1. List of strains, locality, substrate, collection date, herbarium number

<i>Species</i>	<i>Strain</i>	<i>Locality</i>	<i>Subs. (dung)</i>	<i>Date</i>	<i>BAFC</i>
<i>A. bahiensis</i>	2	S. M. de los Andes, NQ, Arg.	cow	Jan-87	719
<i>A. bahiensis</i>	16	S. M. de los Andes, NQ, Arg.	cow	Jan-87	734
<i>A. bahiensis</i>	3	S. M. de los Andes, NQ, Arg.	cow	Jan-87	737
<i>A. bahiensis</i>	15	S. M. de los Andes, NQ, Arg.	cow	Jan-87	745
<i>A. gamundiae</i>	4	Recreo, SF, Arg.	cow	Jun-71	748
<i>A. gamundiae</i>	1	Recreo, SF, Arg.	cow	Jun-71	755
<i>A. gamundiae</i>	5	Recreo, SF, Arg.	cow	Jun-71	765
<i>A. gamundiae</i>	7	Recreo, SF, Arg.	cow	Jun-71	766
<i>A. biguttulatus</i>	3	Michigan, USA	rabbit	Jun-69	769
<i>A. biguttulatus</i>	6	Michigan, USA	rabbit	Jun-69	772
<i>A. biguttulatus</i>	4	Michigan, USA	rabbit	Jun-69	775
<i>A. biguttulatus</i>	5	Michigan, USA	rabbit	Jun-69	792
<i>A. furfuraceus</i>	13	New York, USA	cow	May-57	793
<i>A. furfuraceus</i>	14	New York, USA	cow	May-57	794
<i>A. furfuraceus</i>	20	New York, USA	cow	May-57	802
<i>A. michaudii</i>	6	Cdad. Universitaria, BA, Arg.	cow	Abr-94	807
<i>A. michaudii</i>	15	Cdad. Universitaria, BA, Arg.	cow	Abr-94	808
<i>A. michaudii</i>	5	Cdad. Universitaria, BA, Arg.	cow	Abr-94	815
<i>A. michaudii</i>	3	Cdad. Universitaria, BA, Arg.	cow	Abr-94	821
<i>A. crenulatus</i>	1	Campana, PBA, Arg.	cow	Abr-94	826
<i>A. crenulatus</i>	2	Campana, PBA, Arg.	cow	Abr-94	827
<i>A. crenulatus</i>	3	Campana, PBA, Arg.	cow	Abr-94	828
<i>A. crenulatus</i>	4	Campana, PBA, Arg.	cow	Abr-94	829
<i>A. ferrugineus</i>	1	Mburucuyá, CR, Arg.	cuis ^a	Sep-72	830
<i>A. ferrugineus</i>	9	Mburucuyá, CR, Arg.	cuis ^a	Sep-72	831
<i>A. ferrugineus</i>	2	Mburucuyá, CR, Arg.	cuis ^a	Sep-72	832
<i>A. ferrugineus</i>	8	Mburucuyá, CR, Arg.	cuis ^a	Sep-72	833
<i>A. amoenus</i>	55	Guauguaychú, ER, Arg.	cow	Jan-88	836
<i>A. amoenus</i>	108	Guauguaychú, ER, Arg.	cow	Jan-88	837
<i>A. amoenus</i>	54	Guauguaychú, ER, Arg.	cow	Jan-88	838
<i>A. amoenus</i>	107	Guauguaychú, ER, Arg.	cow	Jan-88	840
<i>A. mancus</i>	4	San Pedro, PBA, Arg.	horse	May-91	841
<i>A. mancus</i>	5	San Pedro, PBA, Arg.	horse	May-91	847
<i>A. mancus</i>	3	San Pedro, PBA, Arg.	horse	May-91	848
<i>A. mancus</i>	6	San Pedro, PBA, Arg.	horse	May-91	849
<i>A. bistisii</i>	8	Ezeiza, PBA, Arg.	cow	Mar-94	850
<i>A. bistisii</i>	10	Ezeiza, PBA, Arg.	cow	Mar-94	851

Table 1, continued

<i>A. bistisii</i>	7	Ezeiza, PBA, Arg.	cow	Mar-94	852
<i>A. bistisii</i>	9	Ezeiza, PBA, Arg.	cow	Mar-94	853
<i>A. immersus</i>	3	Guauguaychú, ER, Arg.	cow	Jan-88	854
<i>A. immersus</i>	9	Guauguaychú, ER, Arg.	cow	Jan-88	855
<i>A. immersus</i>	7	Guauguaychú, ER, Arg.	cow	Jan-88	856
<i>A. immersus</i>	10	Guauguaychú, ER, Arg.	cow	Jan-88	857
<i>A. stictoides</i>	4	Campana, PBA, Arg.	cow	Abr-94	858
<i>A. stictoides</i>	5	Campana, PBA, Arg.	cow	Abr-94	859
<i>A. stictoides</i>	6	Campana, PBA, Arg.	cow	Abr-94	860
<i>A. stictoides</i>	7	Campana, PBA, Arg.	cow	Abr-94	863

^a *Cavia aperea*. BA: Buenos Aires, PBA: province of Buenos Aires, CR: province of Corrientes, ER: province of Entre Ríos, NQ: province of Neuquén, SF: province of Santa Fe.

stored at -70°C until used (Dessauer et al. 1984). Mycelia grew as tough balls and, therefore they were frozen in liquid nitrogen and ground in a mortar at least three times. Finally, they were ground with extraction buffer (0.1 M Tris-HCl (pH 7.5); 0.1% v/v 2-mercaptoethanol; 0.001 M EDTA; 0.01 M KCl; 0.01 M $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$; 10% PVP 10.000) (Soltis et al. 1983), fractioned and frozen at -70°C until used (Dessauer et al. 1984). Samples used and the polarity of the different monospore strains are listed in Table 2.

Polyacrylamide gels and enzymatic dying. Horizontal gel electrophoresis was used (Beckman & Johnson 1964) employing 7% polyacrylamide gels (Saidman 1985). Buffer solutions for gels varied according to the isozyme system analyzed. Thirteen different enzyme systems were analyzed and enzymes with good resolution for all isolates were chosen: IDH (isocitrate dehydrogenase) EC: 1.1.1.42; GDH (NADP) (glutamate dehydrogenase) EC: 1.4.1.3; EST (esterase) EC: 3.1.1...; AAT (aspartate aminotransferase) EC: 2.6.1.1; SOD (superoxide dismutase) EC: 1.15.1.1; ACP (acid phosphatase) EC: 3.1.3.2.

The gel buffer (A) and electrode buffer (a) for each enzyme were: (A) Tris-citrate, pH 8.5 / (a) Lithium borate, pH 8.1 (Scandalios 1969; Saidman 1985); EST, AAT, SOD. (A) Tris-citrate, pH 6.5 / (a) Tris-citrate, pH 7 (Selander et al. 1971; Saidman 1985); ACP, GDH (NADP), IDH.

Dying techniques for ACP and IDH were performed according to Manchenko (1994), for EST and SOD according to Wendel & Weeden (1989) and for AAT according to Vallejos (1983). After the samples were thawed, extracts were absorbed in Whatman 3 MM paper rectangles (2 mm x 4 mm), which were introduced into the grooves made in the gels. They were then covered with a solution of bromophenol-blue (4 mg/ml) which marked the front of the electrophoretic run. Electrophoresis was carried out at a constant temperature of 4°C using a potential difference of 120 volts for approximately 5 h, after which the different bands of enzymatic activity were developed. The distance of each band from the origin was measured in each enzymatic system and the Rf was determined as the ratio between the migration distance of each band relative to the bromophenol-blue front.

Table 2. *Ascobolus* strains and their polarity

Section <i>Ascobolus</i>				Section <i>Dasyobolus</i>			
Key	Species	Strain	Pol.	Key	Species	Strain	Pol.
bah	<i>A. bahiensis</i>	2	+	fer	<i>A. ferrugineus</i>	1	+
bah	<i>A. bahiensis</i>	16	+	fer	<i>A. ferrugineus</i>	9	+
bah	<i>A. bahiensis</i>	3	-	fer	<i>A. ferrugineus</i>	2	-
bah	<i>A. bahiensis</i>	15	-	fer	<i>A. ferrugineus</i>	8	-
bah	<i>A. bahiensis</i>	2+3	mix	fer	<i>A. ferrugineus</i>	1+2	mix
bah	<i>A. bahiensis</i>	16+15	mix	fer	<i>A. ferrugineus</i>	9+8	mix
gam	<i>A. gamundiae</i>	4	+	amo	<i>A. amoenus</i>	55	+
gam	<i>A. gamundiae</i>	1	+	amo	<i>A. amoenus</i>	108	+
gam	<i>A. gamundiae</i>	5	-	amo	<i>A. amoenus</i>	54	-
gam	<i>A. gamundiae</i>	7	-	amo	<i>A. amoenus</i>	107	-
gam	<i>A. gamundiae</i>	4+5	mix	amo	<i>A. amoenus</i>	55+54	mix
gam	<i>A. gamundiae</i>	1+7	mix	amo	<i>A. amoenus</i>	108+107	mix
big	<i>A. biguttulatus</i>	3	+	amo	<i>A. amoenus</i>	108+54	mix
big	<i>A. biguttulatus</i>	6	+	amo	<i>A. amoenus</i>	55+107	mix
big	<i>A. biguttulatus</i>	4	-	man	<i>A. mancus</i>	4	+
big	<i>A. biguttulatus</i>	5	-	man	<i>A. mancus</i>	5	+
big	<i>A. biguttulatus</i>	3+4	mix	man	<i>A. mancus</i>	3	-
big	<i>A. biguttulatus</i>	6+5	mix	man	<i>A. mancus</i>	6	-
fur	<i>A. furfuraceus</i>	13	+	man	<i>A. mancus</i>	4+3	mix
fur	<i>A. furfuraceus</i>	14	-	man	<i>A. mancus</i>	5+6	mix
fur	<i>A. furfuraceus</i>	20	-	bis	<i>A. bistisii</i>	8	+
fur	<i>A. furfuraceus</i>	13+14	mix	bis	<i>A. bistisii</i>	10	+
fur	<i>A. furfuraceus</i>	19+20	mix	bis	<i>A. bistisii</i>	7	-
mich	<i>A. michaudii</i>	6	+	bis	<i>A. bistisii</i>	9	-
mich	<i>A. michaudii</i>	15	+	bis	<i>A. bistisii</i>	8+7	mix
mich	<i>A. michaudii</i>	5	-	bis	<i>A. bistisii</i>	10+9	mix
mich	<i>A. michaudii</i>	3	-	imm	<i>A. immersus</i>	3	+
mich	<i>A. michaudii</i>	6+5	mix	imm	<i>A. immersus</i>	9	+
mich	<i>A. michaudii</i>	15+3	mix	imm	<i>A. immersus</i>	7	-
cren	<i>A. crenulatus</i>	1	homo	imm	<i>A. immersus</i>	10	-
cren	<i>A. crenulatus</i>	2	homo	imm	<i>A. immersus</i>	3+7	mix
cren	<i>A. crenulatus</i>	3	homo	imm	<i>A. immersus</i>	9+10	mix
cren	<i>A. crenulatus</i>	4	homo	stic	<i>A. stictodeus</i>	4	homo
				stic	<i>A. stictodeus</i>	5	homo
				stic	<i>A. stictodeus</i>	6	homo
				stic	<i>A. stictodeus</i>	7	homo

Numerical methods and grouping analysis. The 69 samples analyzed constituted the operative taxonomic units (OTU). Forty-one characters were analyzed, represented by the bands of enzymatic activity. Bands common to all OTUs were excluded and each character was coded as 1 (present) or 0 (absent) for all samples. The resulting matrix consisted of 69 OTUs x 41 characters. From the basic matrix, the coefficient of similarity of Gower (Sneath & Sokal 1973) was calculated for each possible OTU pair. The resulting matrix was analyzed by the unweighted pair-group method using arithmetic averages (UPGMA) (Sneath & Sokal 1973) employing the Multivariate Statistical Package programme (MVSP) (Kovach 1993). The distortion produced during the grouping analysis was calculated using the coefficient of phenetic correlation (r) (Sokal & Rohlf 1962) using the program NTSYS-PC (Rohlf 1993).

Results

Enzyme systems which showed good resolution for all samples were: AAT, EST, ACP, GDH, IDH and SOD. Forty-one electromorphs were found. No differences were found between different monosporic strains in each species or in the mixed cultures, revealing that the species of *Ascobolus* show high intraspecific homogeneity. Only ACP and EST showed some differences between certain isolates of the same species. The analysis of the six enzymatic systems reveals the existence of four monomorphic systems (AAT, GDH, IDH and SOD) and two polymorphic systems (ACP and EST). In the monomorphic systems there are no variations either within strains of the same species or in the mixed samples. The mixed sample 1+7 of *A. gamundiae* presented a different pattern from the rest of the strains and mixed samples for EST. ACP is another polymorphic system in which three band patterns appear for the same species.

Figure 1 shows the diagrams of the electromorphs for each enzyme system with all forty-one electromorphs found. The aspartate aminotransferase system (fig. 1, a) exhibited electromorphs characteristic of each species (A, C, D, E and F) and electromorphs common to more than one species (B, G and H). The acid phosphatase system (fig. 1, b) showed band patterns characteristic for each species (A, D and E), patterns common to more than one species (B and C) and three band patterns for *A. ferrugineus* (F, G and H) one of which is common to *A. amoenus* (F). The esterase system showed the largest isozyme variation; figure 1 c shows a characteristic pattern for each species and two patterns corresponding to *A. gamundiae*, the only species which exhibited a slight variation in one of the mixed samples. Electrophoretic patterns A to G belong to the species of the section *Ascobolus*: *A. bahiensis*, *A. biguttulatus*, *A. furfuraceus*, *A. michaudii* and *A. crenulatus* (with no intraspecific variation) and *A. gamundiae* (two bands appeared common to the pattern A of the mixed sample). Patterns H to M belong to the section *Dasyobolus*: *A. ferrugineus*, *A. amoenus*, *A. mancus*, *A. bistisii*, *A. immersus*, *A. stictoides*. The glutamate dehydrogenase system presented only two electromorphs (fig. 1,d), one for *A. bahiensis* (B), and another common to the rest of the species (A). The isocitrate dehydrogenase system (fig. 1, e), exhibits five electromorphs, each with two different bands, and only one of them was characteristic for one species (electromorph B for *A. stictoides*). The superoxide dismutase system (fig. 1, f) shows five band patterns (A to E) of which pattern B is the only one present as a single band. In this system we also found characteristic patterns for each species (A, C and E) and patterns common to more than one species (B and D).

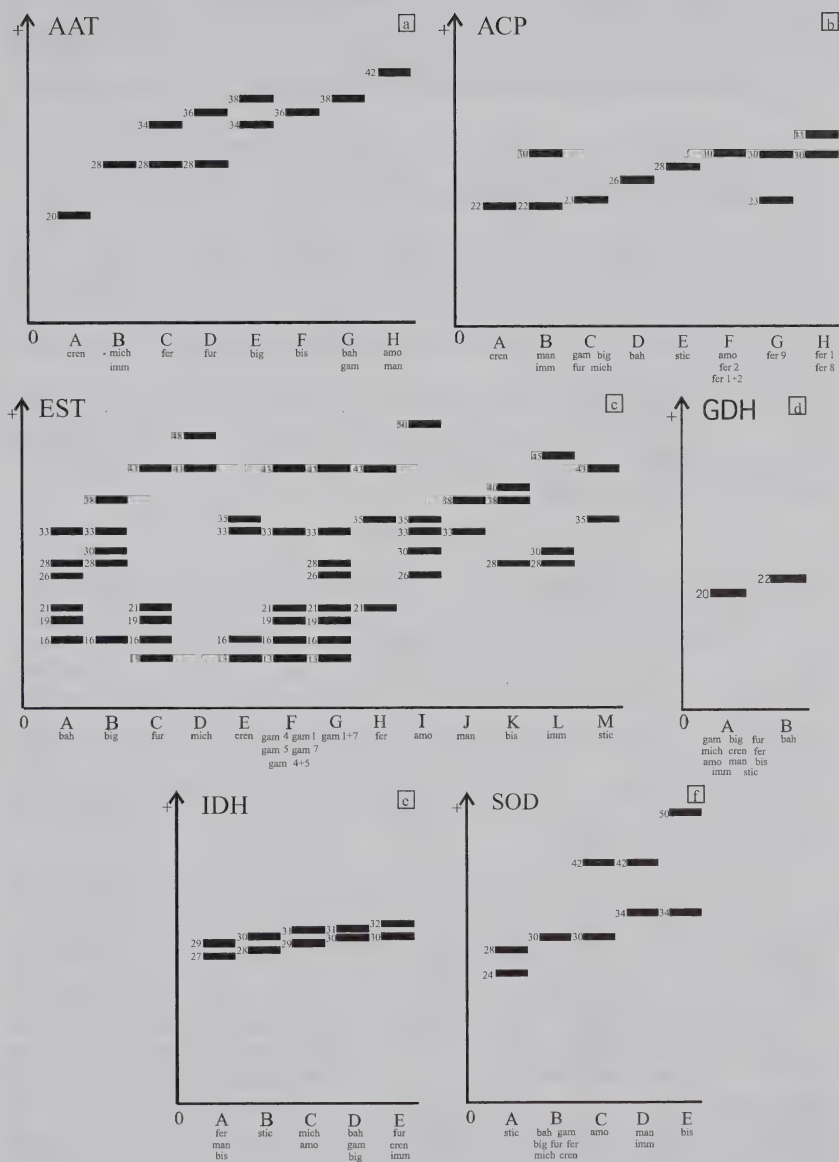


Figure 1. Electromorphs (A-M) in each system. Numbers indicate Rf. a: aspartate aminotransferase; b: acid phosphatase; c: esterase; d: glutamate dehydrogenase; e: isocitrate dehydrogenase; f: superoxide dismutase.

The phenogram obtained from analysis of the data matrix (figure 2) shows two major groups of species associated with a degree of similarity greater of 75%, one of them includes *A. bahiensis* whereas the other includes *A. biguttulatus*. The second subgroup also includes two conjuncts associated with a degree of similarity of approximately 75%, one of them is formed by *A. gamundiae* and *A. furfuraceus*, and the other by *A. crenulatus*.

The second major group comprises all the species belonging to section *Dasybolus* and *A. michaudii* from section *Ascobolus*. This group contains two subgroups associated with a degree of similarity of approximately 63%. The first includes *A. bistisii* whereas the second, larger subgroup contains the remaining species. Conjuncts in this second subgroup are associated with a degree of 65%. The first conjunct is formed by *A. michaudii*, *A. ferrugineus* and *A. stictoides* (degree of similarity 75%) and the second contains *A. amoenus*, *A. mancus* and *A. immersus* (degree of similarity approximately 65%). *Ascobolus stictoides* is associated to *A. ferrugineus* and *A. michaudii* with a degree of similarity of 75%.

There is no intraspecific variation between monosporic strains or within mixed samples with the exception of *A. gamundiae* (mixed sample 1+7) and *A. ferrugineus*. In the latter species strain 9 is an independent OTU while two separate conjuncts are formed by the remaining strains.

Discussion

Isozyme analysis has been shown to be a valuable tool in the taxonomy of the genus *Tremella*, a taxon with an abundance of monomorphic enzymes and a clear distribution of the electromorphs between the species (Hanson & Wells 1991). Out of the six enzyme systems in *Tremella*, only the glutamate dehydrogenase showed a single band for all samples. This pattern is similar to the determined for *Ascobolus*, an haploid organism which has one locus per enzyme. Rodrigues et al. (1995) have already recorded the appearance of a single band in the pattern for malate dehydrogenase in *Xylaria cubensis*, another haploid species. *Colletotrichum gloeosporioides*, a plant parasite from Malaysia, also presents just one band for the glutamate dehydrogenase system (Kanapathipillai 1995).

The appearance of more than one band in some samples for the rest of the enzyme systems is believed to represent the existence of gene duplication or secondary enzymes (Harris and Hopkinson 1976; Micales et al. 1992). Huss et al. (1996), working with six mating populations of *Gibberella fujikuroi* (*Fusarium* sect. *Liseola*) suggested that esterase and acid phosphatase vary enough within a mating population to be used in the intraspecific analysis of populations. The polymorphism present in the esterase and acid phosphatase within the mating population of *G. fujikuroi* observed by Kathariou (1981) is not the same observed by Huss et al. (1996) and probably reflects differences in the buffers used. Esterase and acid phosphatase systems have also been used in the intraspecific analysis of isolates of *Beauveria brogniartii*, a parasite with different degrees of infection on the larvae of bumble bees in Europe (Reineke & Zebita 1996), and in a study of phenotype and genotype variation in *Aspergillus fumigatus* (Rinyu et al. 1995). For the genus *Saccobolus*, a member of family *Ascobolaceae*, esterase proved to be the only system which showed differences in the band pattern within some geographical isolates of the same species (Ramos et al. 2000).

For *Pleurotus ostreatus* (May & Royse 1988) and *Agaricus campestris* (May & Royse 1982), great intraspecific variation was found for different isozyme systems but only those showing little or no intraspecific variation were used. When this variation overlaps interspecific variation, the method becomes inefficient for species separation; therefore, isozyme markers with limited intraspecific variation are recommended when interspecific variability is to be studied.

Maghrabi & Kish (1985 ab, 1986, 1987), working with *Ascosphaerales*, suggested that intraspecific similarities (mating types within a species) were higher than the interspecific isozyme similarity. This was observed with esterase, hexokinase, leucinaminopeptidase and phosphoglucomutase systems in strain (+), (-) and (+-) of *Ascosphaera apis* and *A. asterophora*. These results were confirmed by the application of the genetic identity degree (I) and genetic distance (D) of Nei to *A. apis* with the species *A. proliperda* and *A. aggregata* both homothallic, and to *A. asterophora* with *A. atra* and *A. major* also homothallic. In the acid phosphatase isozyme system of *A. asterophora*, the same band pattern was found for strains (+), (-) and (+-). In *A. apis*, strains (+) and (+-) showed a common pattern, different from the (-) strain. A similar pattern was observed in *A. ferrugineus* and *A. gamundiae*.

In *Phytophthora infestans* there is an association between the mating type and the patterns for glucose phosphate isomerase, peptidase and malic enzyme (Mosa et al. 1993). In all isolates of *Mucor pyriformis* from the same host, the band pattern for malate dehydrogenase, glucose-6-phosphate dehydrogenase and esterase vary within (+), (-) and neutral strains. Harrington et al. (1996), working with *Ceratocystis coerulea*, suggested that the degree of intraspecific variation is related to the mating type system. That heterothallic species showed a greater isozyme variation than homothallic species may be due to a change in the mating type mechanism. Burdon et al. (1981, 1983) found that in *Puccinia graminis* f. sp. *tritici* there was no isozyme variation associated with asexual reproduction. The same was observed for *Phakopsora pachyrhizi* (Bonde et al. 1988) and *Puccinia striiformis* (Newton et al. 1985), both pathogens which do not reproduce sexually. The low intraspecific variation allowed us to use interspecific variations and show clear delimitation of the different species. Other authors also use isozyme systems with very low or no variation at all within the species (Vágvölgyi et al. 1996; Oudemans & Coffey 1991a b; May & Royse 1988).

Homothallism within coprophilous species probably originated as an adaptation to the substrate, which operates to isolate fungi and make it difficult for heterothallic species to meet a compatible mycelium (Wicklow 1981). Sexual reproduction allows the dispersal of the ascospores by means of effective discharge methods. The homothallic, haploid organisms, produce cloned offspring with no genetic variation, while the heterothallic ones, by the process of genetic recombination, produce offspring with genetic variations (Rayner 1990).

Coprophilous fungi live in a relatively homogenous substratum and environment given by special conditions of nearly constant humidity, temperature and composition, rendering it a very particular microclimate.

Species which grow in relatively uniform conditions show scarce isozyme variation (Newton 1987; Newton et al. 1985). In a changing environment, on the other hand, different enzyme forms would exist (Johnson 1974). Cellular components used as

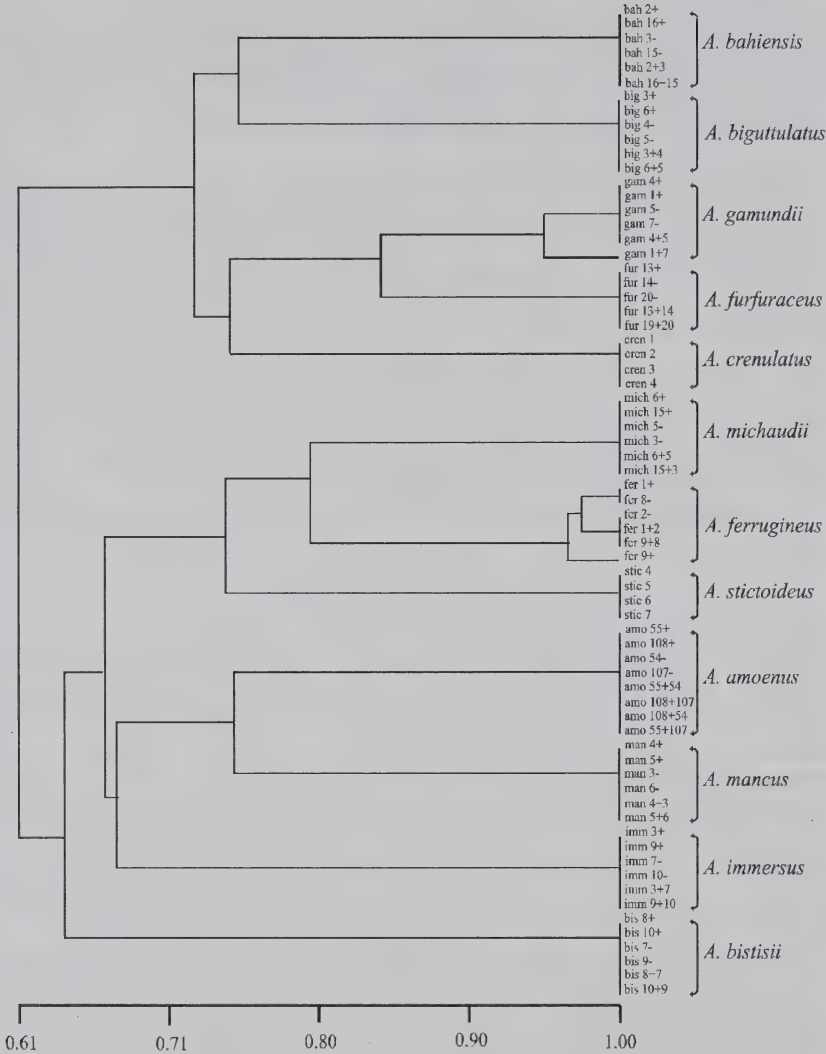


Figure 2: Phenogram obtained from the isozyme analysis. UPGMA cluster analysis

markers are influenced, in many cases, by the composition and pH of the growth media, incubation temperature, as well as by type and age of the culture. This is why Chang & Mills (1992) working with *Psilocybe subaeruginosa*, underline the importance of keeping all cultures at the same physiological state. The great diversity found in the population of *Histoplasma capsulatum* (Hamrick et al. 1986) was due to the heterogeneity of the experimental conditions. This reinforces our idea of the importance of standardizing all cultures if comparisons among organisms are to be studied (Dokmetzian & Ranalli 1998).

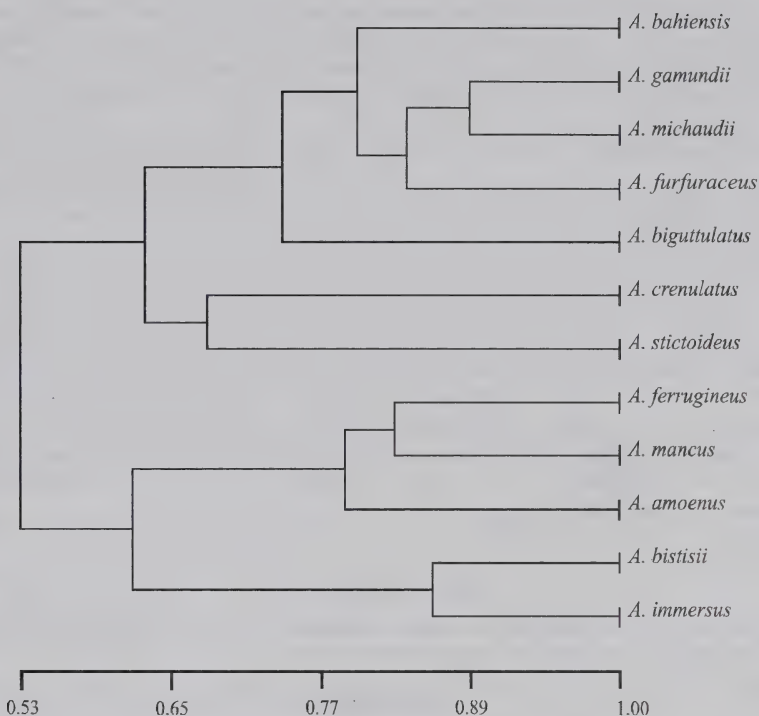


Figure 3: Phenogram obtained from morphological characters analysis. UPGMA cluster analysis. From Dokmetzian & Ranalli (2001)

We expected to find a hormonal interaction between strains (+), (-) and mixed cultures of heterothallic strains of *Ascobolus* species, which would appear in some of the analyzed systems. As fruiting bodies are only produced on solid medium as a response to hormonal interaction (Dokmetzian & Ranalli 1994), no great differences were found in the mixed samples, either because it was a liquid culture or because the isozyme systems analyzed in this case were not involved directly in this sexual process. We only found some differences in the mixed sample of *A. gamundiae* 1+7 for esterases and of *A. ferrugineus* 1+2 and 9+8 for acid phosphatase.

To prove the existence of any type of interaction between the mutant and hybrid strain in *A. amoenus* (Dokmetzian et al. 1995), we cultured together the mixed samples of the wild homozygous 55+54, the mutant homozygous 108+107 and the heterozygous 108+54 and 107+55. No differences in any of the enzyme systems studied were found in any of the eight samples (4 individual strains and 4 mixed cultures), probably because they were not involved in exosporium formation or because it was a liquid culture where no fruiting bodies were obtained.

In the phenogram (figure 2), *A. michaudii* is grouped with the species of the section *Dasyobolus*. The degree of similarity with *A. stictoides* is 75% and with *A. ferrugineus* of around 80%. When we analyzed the band patterns we noticed that *A. michaudii*

had the same pattern for the aspartate aminotransferase system as *A. immersus* and *A. stictoides*, and the same pattern for isocitrate dehydrogenase as seen in *A. amoenus*. The acid phosphatase electromorph is the same in *A. gamundiae*, *A. biguttulatus* and *A. furfuraceus* (section *Ascobolus*) and in *A. bistisii* and one band of *A. ferrugineus* (Rf 23) (section *Dasyobolus*). The superoxide dismutase system exhibits a common pattern to all species of section *Ascobolus* and to *A. ferrugineus* and one band (Rf 30) of *A. amoenus* of section *Dasyobolus*. *A. bistisii* seems to be clearly separated from the group which includes the rest of the species of the section. This is probably related to the fact that it is the only one which produces oidia.

When morphological (figure 3) and isozyme phenograms are analyzed there is a very high association between species (Dokmetzian & Ranalli 2001). This agrees with the continuum of the morphological characters due to overlapping in some characters analyzed, preferably quantitative ones. The presence of common bands in some species may be related to this overlapping of morphological characters. Differences in the degree of similarity in the morphological and isozyme phenograms are probably caused by working with the reproductive stage in the morphological phenogram and with the vegetative growth in the case of isozyme analysis. These differences produced the sorting of groups within the two sections.

Acknowledgements

We acknowledge the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) and the University of Buenos Aires Argentina for financial support.

Literature cited

- Backhouse D, Willetts HJ, Adam P. 1984. Electrophoretic studies of *Botrytis* species. Trans. Br. Mycol. Soc. 82: 625-630.
- Beckman L, Johnson FM. 1964. Esterase variation in *Drosophila melanogaster*. Hereditas 51: 51-212.
- Bielenin A, Jeffers SN, Wilcox WF, Jones AL. 1988. Separation by protein electrophoresis of six species of *Phytophthora* associated with deciduous fruit crops. Phytopathology 78: 1402-1408.
- Bistis GN. 1956. Sexuality in *Ascobolus stercorarius* I. Morphology of the ascogonium; plasmogamy; evidence for a sexual hormonal mechanism. Am. J. Bot. 43: 389-394.
- Bistis GN. 1957. Sexuality in *Ascobolus stercorarius* II. Preliminary experiments on various aspects of the sexual process. Am. J. Bot. 44: 436-443.
- Bistis GN, Raper J. 1963. Heterothallism and sexuality in *Ascobolus stercorarius*. Am. J. Bot. 50: 880-891.
- Bonde MR, Peterson GL, Dowler WM. 1988. A comparison of isozyme of *Phakopsora pachyrhizi* from the eastern hemisphere and the new world. Phytopathology 78: 1491-1494.
- Boudier JLE. 1869. Mémoire sur les Ascobolées. Ann. Sci. Nat. 10: 191-268.
- Brummelen J van. 1967. A world monograph of the genera *Ascobolus* and *Saccobolus* (Ascomycetes, Pezizales). Persoonia (Suppl.) I: 1-260.
- Burdon JJ, Luig NH, Marshall DR. 1983. Isozyme uniformity and virulence variation in *Puccinia graminis* f. sp. *tritici* and *P. recondita* f. sp. *tritici* in Australia. Australian J. Biol. Sci. 36: 403-410.

- Burdon JJ, Marshall DR, Luig NH. 1981. Isozyme analysis indicates that a virulent cereal rust pathogen is a somatic hybrid. *Nature* 293: 565-566.
- Chang YS, Mills AK. 1992. Re-examination of *Psilocybe subaeruginosa* and related species with comparative morphology, isozymes and mating compatibility studies. *Mycol. Res.* 96: 429-441.
- Cruickshank RH, Pitt JI. 1987. Identification of species in *Penicillium* subgenus *penicillium* by enzyme electrophoresis. *Mycologia* 79: 614-620.
- Dessauer HC, Cole CJ, Hafner MS. 1984. Collection and storage of tissues in *Molecular Systematics*. D. M. Hillis and C. Moritz Eds. Sinauer Assoc. Inc. MA. USA. 588 p.
- Dokmetzian DA, Ranalli ME. 1994. Ensayos de incompatibilidad e hibridación en especies de *Ascobolus*. *Physis* (BA), Sec C 49: 37-44.
- Dokmetzian DA, Ranalli ME. 1998. Crecimiento de especies del género *Ascobolus* (*Pezizales*, *Ascomycetes*). *Rev. Arg. Microbiol.* 30: 195-199.
- Dokmetzian DA, Ranalli ME. 2001. Taxonomía de algunas especies del género *Ascobolus* (*Ascomycetes* – *Pezizales*). *Physis* (BA) Sec C 58: 103-108.
- Dokmetzian DA, De Simone S, Ranalli ME. 1995. Estudio sistemático y biológico de las Ascolóceas de Argentina XVI. Un mutante natural de *Ascobolus amoenus*. *Bol. Soc. Arg. Bot.* 30: 231-239.
- Gamundí IJ, Ranalli ME. 1964. Estudio sistemático y biológico de las Ascolóceas de Argentina I. *Nova Hedwigia* VII: 517-533.
- Gottlieb AM, Saidman BO, Wright JE. 1998. Isoenzymes of *Ganoderma* species from southern South America. *Mycol. Res.* 102 (4): 415-426.
- Hamrick JL, Lichtwardt RW, Lan CW. 1986. Levels of isozyme variation within and among *Histoplasma capsulatum* localities. *Trans. Kansas Acad. Sci.* 89: 49-56.
- Hanson LC, Wells K. 1991. Compatibility and population structure of three species of *Tremella* (*Heterobasidiomycetes*). *Mycologia* 83: 273-287.
- Harrington TC, Steimel JP, Wingfield MJ, Kile GA. 1996. Isozyme variation and species delimitation in the *Ceratocystis coerulea* complex. *Mycologia* 88: 104-113.
- Harris H, Hopkinson DA. 1976. *Handbook of enzyme electrophoresis in human genetics*. North Holland Biomedical Press, Amsterdam.
- Hepper CM, Sen R, Azcon-Aguilar C, Grace C. 1988. Variation in certain isozymes amongst different geographical isolates of the vesicular-arbuscular mycorrhizal fungi *Glomus clarum*, *G. monosporum* and *G. mosseae*. *Soil. Biol. Biochem.* 20: 51-59.
- Huss MJ, Campbell CL, Jennings DB, Leslie J F. 1996. Isozyme variation among biological species in the *Gibberella fujikuroi* species complex (*Fusarium* Section *Liseola*). *Appl. Environ. Microbiol.* 62: 3750-3756.
- Johnson GB. 1974. Enzyme polymorphism and metabolism. *Science* 184: 28-37.
- Kanapathipillai VS. 1995. Preliminary studies of isozyme patterns of isolates of *Colletotrichum gloeosporioides* from hosts plants in Malaysia. *Pertanika J. Trop. Agri. Sci.* 18: 135-139.
- Kathariou S. 1981. Gene pool organization in *Fusarium moniliforme*. Ph. D. dissertation. University of California, Berkeley.
- Kerrigan RW, Ross IK. 1988. Extracellular laccases: biochemical markers for *Agaricus* systematics. *Mycologia* 80: 689-695.
- Kovach WL. 1993. MVSP – A multivariate statistical package for IBM-PCs. version 2. I. Kovach Computing Services, Pentraeth, Wales, UK.
- Maghrabi HA, Kish LP. 1985a. Isozyme characterization of *Ascosphaerales* associated with bees. I. *Ascosphaera apis*, *A. proliperda* and *A. aggregata*. *Mycologia* 77: 358-365.

- Maghrabi HA, Kish LP. 1985b. Isozyme characterization of *Ascosphaerales* associated with bees. II. *Ascosphaera major*, *A. atra* and *A. asterophora*. *Mycologia* 77: 366-372.
- Maghrabi HA, Kish LP. 1986. Isozyme characterization of *Ascosphaerales* associated with bees. III. *Betsia alvei*. *Mycologia* 78: 676-677.
- Maghrabi HA, Kish LP. 1987. Isozyme characterization of *Ascosphaerales* associated with bees. IV. Analyses. *Mycologia* 79: 519-523.
- Manchenko P. 1994. Handbook of detection of enzymes on electrophoretic gels. CRC Press, Boca Raton, Florida, USA. 341 p.
- May B, Royse D J. 1982. Genetic variation and joint segregation of biochemical loci in the common meadow mushroom *Agaricus campestris*. *Biochem. Genet.* 20: 1165-1173.
- May B, Royse D J. 1988. Interespecific allozyme variation within the fungal genus *Pleurotus*. *Trans. Br. Mycol. Soc.* 90: 29-36.
- Micales JA, Bonde MR, Peterson GL. 1992. Isozyme analysis in fungal taxonomy and molecular genetics. In: Handbook of Applied Mycology. Arora, D. K. (eds.) Vol. 4: 57-79.
- Mosa AA, Kobayashi K, Ogoshi A, Kato M, Sato N. 1993. Isozyme polymorphism and segregation in isolates of *Phytophthora infestans* from Japan. *Plant. Pathol.* 42: 26-34.
- Newton AC. 1987. Markers in pathogen populations. In: Genetics and plant Pathogenesis (P. R. Day and G. J. Jellis, eds.), Blackwell Scientific, Oxford, p 187-194.
- Newton AC, Caten CE, Johnson R. 1985. Variation for isozymes and double-stranded RNA among isolates of *Puccinia striiformis* and two other cereal rusts. *Plant. Pathol.* 34: 235-247.
- Oudemans P, Coffey MD. 1991a. Isozyme comparison within and among worldwide sources of three morphologically distinct species of *Phytophthora*. *Mycol. Res.* 95: 19-30.
- Oudemans P, Coffey MD. 1991b. A revised systematics of twelve papillate *Phytophthora* species based on isozyme analysis. *Mycol. Res.* 95: 1023-1046.
- Ramos AM, Ranalli ME, Saidman BO. 2000. Isozyme analysis of different species of *Saccobolus*. *Mycotaxon* 74: 447-462.
- Ranalli ME, Gamundí IJ. 1975. *Ascobolus biguttulatus* sp. nov. (Ascomycetes, *Pezizales*). *Estudios de cultivo y citología. Physis (BA) Sec C* 34: 1-15.
- Rayner ADM. 1990. Natural genetic transfer systems in higher fungi. *Trans. Mycol. Soc. Jap.* 31: 75-87.
- Reineke A, Zebita CPW. 1996. Protein and isozyme patterns among isolates of *Beauveria brogniartii* with different virulence to European cockchafer larvae (*Melolontha melolontha*). *J. Appl. Entomol.* 120: 307-315.
- Rinyu E, Varga J, Ferenczy L. 1995. Phenotypic and genotypic analysis of variability in *Aspergillus fumigatus*. *J. Clin. Microbiol.* 33: 2567-2575.
- Rodrigues KF, Petrini O, Leuchtmann A. 1995. Variability among isolates of *Xylaria cubensis* as determined by isozyme analysis and somatic incompatibility tests. *Mycologia* 87: 592-596.
- Rohlf JF. 1993. NTSYS-PC. Numerical Taxonomy and Multivariate Analysis System. Version 1.8 Exeter Software Applied Biostatistics Inc., N. Y.
- Saidman BO. 1985. Estudio de la variación alozímica en el género *Prosopis*. Tesis para optar al título de Doctor en Ciencias Biológicas. Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires. 231 pp.
- Scandalios JG. 1969. Genetic control of multiple molecular forms of enzymes in plants, a review. *Biochem. Genet.* 3: 37-79.
- Selander RK, Smith MH, Yang SY, Johnson WE, Gentry JB. 1971. Biochemical polymorphism and systematics in the genus *Peromyscus*. I. Variation in the old-field mouse (*Peromyscus polionotus*). *University Texas Publ.* 103: 49-90.

- Sneath PH, Sokal RR. 1973. Numerical Taxonomy. The Principles and Practice of Numerical Classification. W. H. Freeman and Co., San Francisco, USA. 573 p.
- Sokal RR, Rohlf FJ. 1962. The comparison of dendrograms by objective methods. *Taxon* 11:- 33-40.
- Soltis DE, Haufler CH, Darrow DC, Gastony GJ. 1983. Starch gel electrophoresis of Ferns. A compilation of grinding buffers, gel and electrode buffers, and staining schedules. *Amer. Fern J.* 73: 9-27.
- Vágvölgyi C, Papp T, Palágyi Z, Michailides TJ. 1996. Isozyme variation among isolates of *Mucor pyriformis*. *Mycologia* 88: 602-607.
- Vallejos CE. 1983. Enzyme activity staining. In *Isozymes in Plant genetics and Breeding*. Eds. S. D. Tanksley and T. J. Orton. A: 469-516. Amsterdam, Elsevier.
- Wendel JF, Weeden NF. 1989. Visualization and interpretation of plant isozymes. In: D. E. Soltis and P. S. Soltis (eds.). *Isozyme in Plant biology*, Cap. 1: 5-45.
- Wicklow DT. 1981. The coprophilous fungal community: A mycological system for examining ecological ideas. In: *The fungal community: Its organization and role in the ecosystem*. Wicklow, D. T. and Carroll, G. (eds.). Marcel Dekker, Inc, New York. 47-76 p.

Two new species of the genus *Paecilomyces* in China

YANFENG HAN, HUALI CHU
& ZONGQI LIANG*

swallow112886@yahoo.com.cn huali1121@163.com

*zqliang472@yahoo.com.cn

Institute of Fungus Resources, Guizhou University
Guiyang 550025, China

Abstract — Two new species, *Paecilomyces stipitatus* and *P. vinaceus*, isolated respectively from soil samples of Wuhan City, Hubei province and Yantai city, Shangdong Province, China, are described and illustrated. The former species is characterized by its white colony, cylindrical or ellipsoidal phialides bases above typically long and septate thin stalks, and subglobose conidia. *P. vinaceus* is distinguished by white colony with a vinaceous reverse, clavate phialides bases, and subglobose to ellipsoidal conidia.

Key words— fungi, *Gabarnaudia*, *Penicillium*, taxonomy, morphology

Introduction

The new genus *Gabarnaudia* Samson & Gams was proposed to accommodate *Oospora betae* Delacr. (Samson 1974). This genus obviously differs from *Paecilomyces* by long awl-shaped phialides which are often integrated in usually basitonously branched septate conidiophores. In this paper we will report a rare new species of *Paecilomyces*, which resembles the species of *Gabarnaudia* in septate stalk of phialides.

Samson (1974) commented that the generic distinction between *Paecilomyces* and *Penicillium* was difficult. *Paecilomyces* is mainly characterized by the shape of the phialides that taper into a long distinct neck and by the divergent aggregation of whorls described by Brown and Smith (1957). In *Penicillium* the phialides are usually flask-shaped with a distinct but short neck and they are arranged in penicillate clusters. The new species, *Paecilomyces vinaceus*, reported in this paper, is characterized by the phialides with both *Paecilomyces*-type and *Penicillium*-type.

Materials and methods

Collection and strains isolation

Strains GZDX-IFR117-1 and GZDX-IFR102-3 were isolated respectively from soil samples collected from Shizishan, Wuhan City, Hubei Province and Yantai city,

* The corresponding author is ZongQi Liang.

Shandong Province, China. Two grams of soil were added to a flask containing 20ml sterilized water and glass beads. Each soil suspension was shaken for about 10min and then diluted to concentrations of 10^{-1} - 10^{-3} . One ml soil suspension (10^{-3}) was mixed with Martin medium in a sterilized 9cm diam Petri dish and incubated at 25°C for 5 days. Colonies with *Paecilomyces* conidiogenous structures were transplanted to Martin's slant for purification.

Strain identification

The studied strains were transplanted on Czapek agar, potato dextrose agar (PDA), and Sabouraud agar according to Brown and Smith (1957) and Samson (1974). After incubation at 25-26°C for 14 days, these strains were identified based on colony character, conidiogenous structure, and biology.

Type strains of *P. stipitatus* GZDX-IFR 117-1 and *P. vinaceus* GZDX-IFR102-1 and their holotypes, the dried plate cultures on Czapek agar, GZDX117-1 and GZDX102-1 were deposited in the Institute of Fungus Resources, Guizhou University, Guizhou province, China.

Description of new species

***Paecilomyces stipitatus* Z.Q. Liang & Y. F. Han sp. nov.**

Fig.1- 6

Coloniae in agar Czapekii ad 50-60 mm diam, 14 diebus 25°C, planae, albae; reversio flava. Hyphae hyalinae, leviae, 1.1-3.5 µm crassa. Conidiophora ramosa, verticillata, phialidibus 2 vel 5 terminatis. Phialides 9.7-24.2 × 1.4-2.5 µm, e basi inflata, cylindrica vel ellipsoidea in collum tenerum, septalis petiole existentia. Conidia continua, hyalina, levia, subglobulosa, ellipsoidea vel fusiformis 1.7-5.9 × 1.3-3.3 µm.

Holotypus hic designatus: GZDX-IFR117-1 et cultura GZDX117-1, isolatus e soli, Shizishania, Wuhanum, provincia Hubei, China, XI, 2003, Y. F. Han & Z. Q. Liang. In Guizhou Univ, conservatur.

Colonies on Czapek agar, attaining a diameter of 50 to 60 mm within 14 days at 25°C, flat, white, felt, regular in the margin; reverse yellowish. Vegetative hyphae hyaline, smooth-walled, 1.1-3.5 µm wide. Conidiophore ramose, directly bearing conidiogenous cell or consisting of verticillate branches with whorls of 2 to 5 phialides. Phialides 9.7-24.2 × 1.4-2.5 µm, consisting of a swollen, cylindrical or ellipsoidal basal portion, usually having a long and septate stalk under the swollen basal portion, tapering into a thin neck, less than 0.5 µm wide. Conidia one-celled, hyaline, smooth-walled, subglobose or ellipsoidal or fusiform, 1.7-5.9 × 1.3-3.3 µm.

Material examined: GZDX-IFR117-1 was isolated by Y. F. Han & Z. Q. Liang from soil of Shizishan, Wuhan, Hubei Province, China, 2003, 11.

Distribution: Hubei & Heilongjiang Provinces, China.

***Paecilomyces vinaceus* Y. F. Han & Z.Q. Liang sp. nov.**

Fig. 7- 9

Coloniae in agar Czapekii ad 35-40 mm diam, 14 diebus 25°C, albae, deinde, floccae, reversio flava ad vinacea. Hyphae hyalinae, leviae, 1.3-3.7 µm crassa. Conidiophora simplex, rara, verticillata, ramis phialidibus 2 vel 3 terminatis. Phialides 7-15.5 × 1.4-2.8 µm, e basi inflata, clavata in collum tenerum. Conidia continua, hyalina, levia, subglobulosa vel ellipsoidea, 2.6-3.6 × 1.3-2.6 µm.

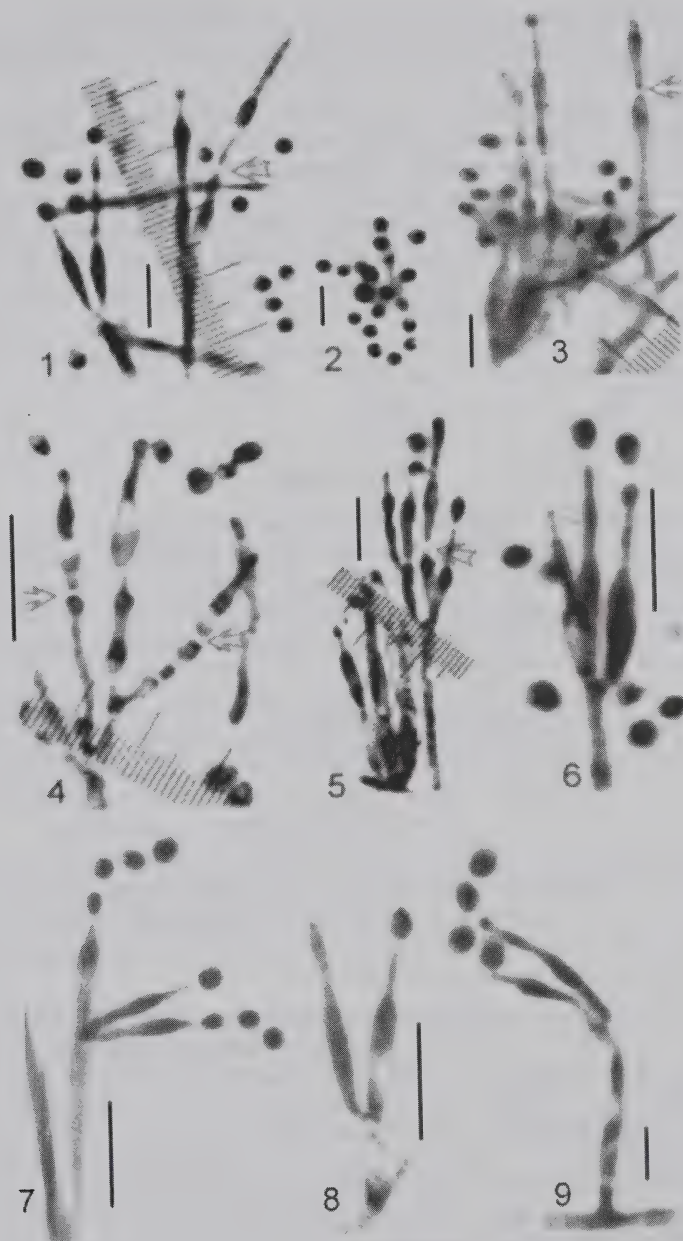


Fig. 1-6 Conidiogenous structure of *P. stipitatus*. 1,3-5. Septate stalk under the basal portion of the phialides; 2. Conidia; 6. A few phialides magnified

Fig. 7-9 Conidiogenous structure of *P. vinaceus*

Bar=10 μm

Holotypus hic designatus: GZDX-IFR102-3 et cultura GZDX102-3, isolatus e soli in Yantai, provincia shandong, China, VIII, 2003, Y. F. Han & Z. Q. Liang. In Guizhou Univ, conservatur.

Colonies on Czapek agar, attaining a diameter of 35 to 40mm within 14 days at 25°C, white, floccose, sometimes having little dewdrop on the surface; reverse yellow to vinaceous from the centre to margin, appearing radial furrow and soluble pigment. Vegetative hyphae hyaline, smooth-walled, 1.3-3.7 µm wide. Conidiophore simple, rare, always consisting of verticillate branches with whorl of 2 to 3 phialides. Phialides 7-15.5 × 1.4 - 2.8 µm, consisting of a swollen, claval basal portion, tapering into a thin neck, less than 0.5 µm wide. Conidia one-celled, hyaline, smooth-walled, subglobose to ellipsoidal, 2.6 - 3.6 × 1.3 - 2.6 µm.

Material examined: GZDX-IFR102-3 was isolated by Y. F. Han & Z. Q. Liang from soil in Yantai, Shandong Province, China, 2003, 8.

Distribution: Shandong Province, China.

Discussion

All species in the genus *Gabarnaudia* have septate stalks under the basal portion of phialides; their phialides are typically awl-shaped and conidiophores usually branch basitonously (Samson 1974). Although the fungus *P. stipitatus* always has a long and septate stalk under the phialides, which distinctly consists of a swollen basal portion and a tapering thin neck, the phialides are not awl-shaped, excluding the fungus from *Gabarnaudia*.

In the genus *Paecilomyces*, *P. stipitatus* is similar to *P. aegyptiacus* Ueda & Udagawa (Ueda & Udagawa 1983) and *P. niveus* Stolk & Salmon (Samson 1974) in the shape of the basal portion of phialides and conidia. But they both are thermophilic with an optimum growing temperature range 35–40°C. *P. stipitatus* is distinguished from all other *Paecilomyces* species by its unique septate stalk at the phialides base.

The fungus *P. vinaceus* is similar to two *Penicillium* species, *Pen. vinaceum* Gilman & Abbott and *Pen. phoeniceum* Beyma (Raper & Thom 1949) in the reverse colour of the colony, the rare, monoverticillate conidiophores, and conidial shape. *P. vinaceus* can be separated from the two *Penicillium* species by its long-necked phialides, large colonies, small whorls, and large conidia (Table 1).

Within *Paecilomyces*, *P. vinaceus* resembles *P. aegyptiacus* (Ueda & Udagawa 1983), *P. carneus* (Duché & R. Heim) A. H. S. Br. & G. Sm. (Brown & Smith 1957), *P. parvus* A. H. S. Br. & G. Sm. (Brown & Smith 1957), *P. simplex* (Petch) A. H. S. Br. & G. Sm. (Brown & Smith 1957), *P. victoriae* (Svilv.) A. H. S. Br. & G. Sm. and *P. niveus* in the shape of the phialides base and conidia. Of these, *P. parvus* was transferred to *Scopulariopsis* based on its conidial formation pattern (Samson 1974); *P. simplex* was transferred to *Verticillium* based on branching differences (Samson 1974); *P. victoriae* was transferred to *Penicillium* (Samson 1974); *P. aegyptiacus* and *P. niveus* are thermophilic (Samson 1974). The rough conidia in *P. carneus* (Brown & Smith 1957) differ from those of *P. vinaceus*. Within *Paecilomyces*, colony reverses in a few species are distinctly coloured, e. g., green in *P. aeruginosus* Samson (Samson 1974), cream to red in *P. amoenerosus* (Henn.) Samson (Samson 1974), bright yellow in *P. farinosus*

Table 1. A comparison of *P. vinaceus* with two similar species of *Penicillium*

Species	Colonies			# of phialides in whorls	Conidia (μm)
	D i a m (mm)	Colour	Texture		
<i>P. vinaceus</i>	35-40	White	Floccose	2-3	Subglobose/ellipsoidal 2.6-3.6 $\times$ 1.3-2.6
<i>Pen. vinaceum</i>	20-25	Light gray	Funiculose	5-8	Subglobose 2-2.5
<i>Pen. phoeniceum</i>	10	White to light pink	Floccose or funiculose	5-12	Subglobose 2.5-3

(Holmsk.) A. H. S. Br. & G. Sm. (Brown & Smith 1957) and *P. tenuipes* (Peck) Samson (Samson 1974), yellow to orange in *P. fumosoroseus* (Wize) A. H. S. Br. & G. Sm. (Brown & Smith 1957), red to violet in *P. lilacinus* (Thom) Samson (Samson 1974), pale rose in *P. marquandii* (Massee) S. Hughes (Han et al. 2003), yellow to green in *P. puntonii* (Vuill.) Nann. (Han et al. 2003), scarlet to yellow in *P. huaxiensis* Z. Q. Liang & Y. F. Han (Han et al. 2004), orange to green in *P. pascua* Pitt & A. D. Hocking (Pitt & Hocking 1985), and yellow brown in *P. atrovirens* Z. Q. Liang & A. Y. Liu (Liang et al. 1993). The vinaceous colour of the colony reverse is diagnostic for *P. vinaceus* and distinguishes it from the other *Paecilomyces* species cited above.

Acknowledgements

This project was supported by the National Natural Science Foundation of China (No.30270011). We are thankful to Professor Ji-chuan Kang and Dr. Sheng-jun Chang for their comments on the manuscript. And we really appreciate editorial revisions.

References

- Brown AHS, Smith G. 1957. The genus *Paecilomyces* Bainier and its perfect stage *Byssosclamyces* Westling. Trans. Brit. Mycol. Soc. 40 (1): 17-89.
- Han YF, Liang ZQ, Chu HL. 2004. Studies on the genus *Paecilomyces* in China II. *Paecilomyces* spp. from Guizhou. Mycotaxon 91: 361-364.
- Han YF, Liang ZQ, Liu AY, Chu HL. 2003. Two new records of *Paecilomyces* in China. Journal of Fungal Research 1: 46-48.
- Liang ZQ, Liu AY, Feng DM. 2003. Some entomogenous fungi from Fanjing Mountain Preserve in China. Acta Mycologica Sinica 12(2): 110-117.
- Pitt JI, Hocking AD. 1985. Interfaces among genera related to *Aspergillus* and *Penicillium*. Mycologia 77: 810-824.
- Raper KB, Thom C. 1949. The manual of the *Penicillia*. The Williams & Wilkins Co., Baltimore, 234-239.

- Samson RA. 1974. *Paecilomyces* and some allied hyphomycetes. Stud. Mycol. 6: 1-119.
- Ueda S, Udagawa SI. 1983. *Thermoascus aegyptiacus*, a new thermophilic ascomycete. Trans. Mycol. Soc. Japan 24(2): 135.

***Aleurocystis gloeocystidiata* sp. nov. on *Polylepis australis* in Argentina**

MARIO RAJCHENBERG¹ & GERARDO L. ROBLEDO²

¹*marior@ciefap.org.ar*

Centro Forestal CIEFAP, C.C. 14, 9200 Esquel, Chubut, Argentina

²*grobledo@imbiv.unc.edu.ar*

Instituto Multidisciplinario de Biología Vegetal – CONICET

Universidad Nacional de Córdoba

C.C. 495, 5000 Córdoba, Córdoba, Argentina

Abstract—The new taxon *Aleurocystis gloeocystidiata* is described, growing on living branchlets of *Polylepis australis* in Central Argentina. It is characterized by a discoid-cupuloid basidiome, ellipsoid basidiospores 17–24 x 12–15 μ m, metuloid cystidia, sulfonegative gloeocystidia, clamped, non-gelatinized generative hyphae, and encrusted skeletocystidia that are present in the context, form the white, hairy margin of the basidiome, and become grayish in Melzer's reagent.

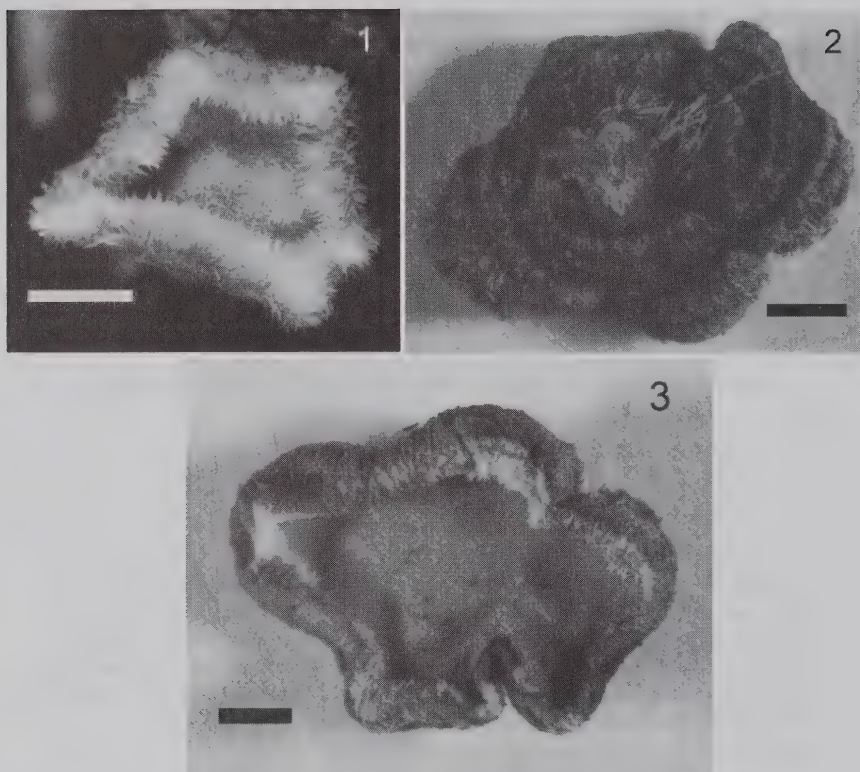
Key words—*Aphyllphorales*, *Corticaceae*, taxonomy

Introduction

In recent years the authors and co-workers began studies of aphyllphoraceous fungi (Hymenomycetes, Basidiomycota) found in *Polylepis* Ruiz & Pavón (*Rosaceae*) woodlands of Argentina. The latter form altitudinal forests in northwest and central Argentina at elevations between 1300–2600m above other forest formations. They are often found in deep canyons and ravines and along water courses, forming patches of vegetation generally isolated from other vegetation types (Simpson 1979). *Polylepis* forests are characterised by a relatively high number of endemic animal species (see review for birds, lepidoptera, and mammals by Fjeldså & Kessler 1996), as is also the case for polypores (Robledo et al. 2003, Urcelay et al. 2000). During our collecting trips we found a cupuloid, corticioid fungus growing on living, terminal branchlets of *Polylepis australis* Bitt., that we distinguish as a new taxon. The aim of this paper is to describe this species and to discuss its distinguishing morphological features.

Material and methods

The study area comprises *Polylepis australis* woodlands of the Sierras Grandes mountains in Córdoba province, Central Argentina (see Robledo et al. 2003 for a map and description of forests).



Figs. 1-3, *Aleurocystis gloecystidiata* (Robledo 267, holotype): macroscopic aspect of the basidiome. Fig. 1, showing hairy margin. Fig. 2, abhymenial surface. Fig. 3, hymenial surface. Bars= 1 mm.

Morphological features of the fungus were observed with a Wild M3Z dissecting microscope and a Zeiss Axioplan compound microscope. Sections of the basidiome were mounted in 3-5% KOH plus 1% phloxine and in Melzer's reagent. The holotype and other collections were deposited in the Herbarium, Museo Botánico, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Argentina (CORD).

Taxonomy

Aleurocystis gloecystidiata Rajchenb. & Robledo sp. nov.

Figs. 1-5

Basidiocarp cupulato, *hymenio* salmonéo vel roseo, *contextus* monomiticus, *hyphae* generatoriae fibulatae, *gloeocystidiae* praesentes, *cystidiae* hymeniales vel subhymeniales cylindricae vel subulatae, *incrustatae*, *crassitunicatae*, *skeletocystidiae* *incrustatae*, in IKI schistaceae, *dendrohyphidiae* desunt; *basidia* claviformibus, 80-110 x 18-20 μ m, *basidiosporae* ellipsoideae, laeves, inamyloideae, 17-24 x 12-15 μ m.

Holotypus hic designatus: Argentina, Córdoba, Parque Nacional Quebrada del Condorito, G.L. Robledo 267, 6.Sep.2004, in ramula terminalis vivae *Polylepis australis*; in herbarium CORD conservatus est.

Basidiocarp annual, pileate, cupulate, discoid to stereoid, dorsally and centrally attached, up to 8 x 6 mm, ellipsoid to more or less circular-discoid, coriaceous, basidiomes growing isolated (i.e. not coalescing), margin curved inward when dry. Abhymenial surface with appressed hairs towards the center, scrupose or strigose towards the margin, hairs tomentose and white in the margin, light brown elsewhere. Hymenial surface light salmon pink, hymenophore smooth, not creviced. Context cream to very light salmon pink colored.

Basidiome $\pm$ to 400 μm thick, consisting of two layers. 1) Upper cortex layer

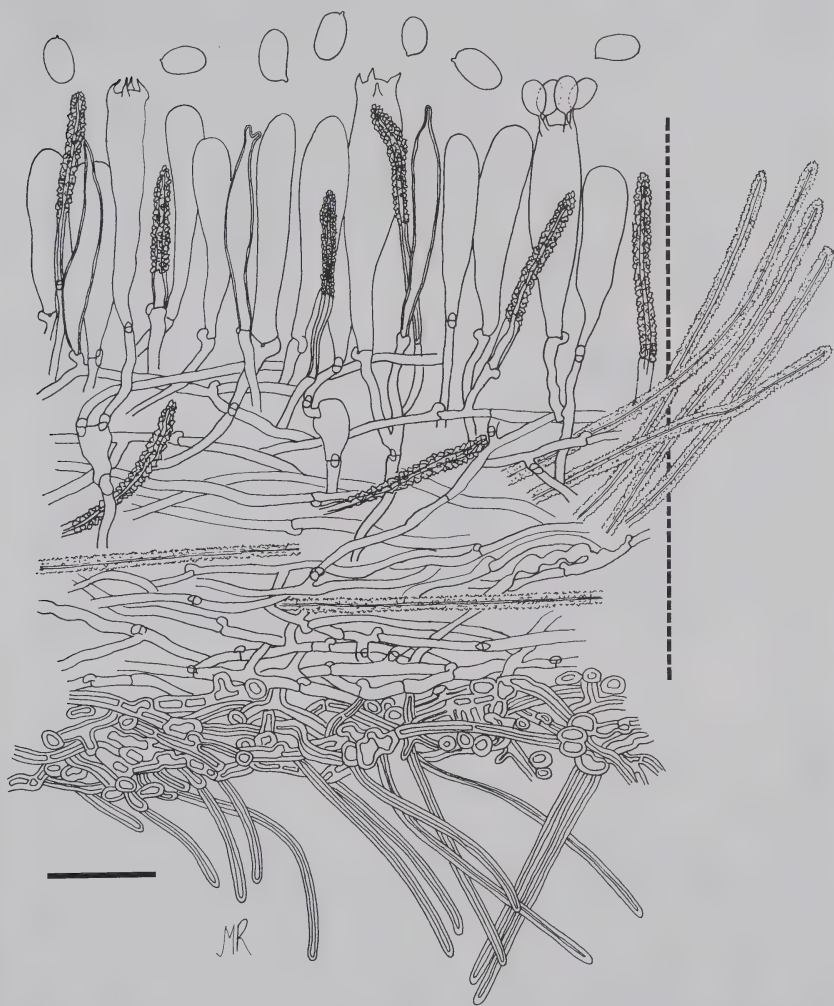


Fig. 4. *Aleurocystis gloeocystidiata* (Robledo 267, holotype), cross section of the basidiome. At the right, detail of the margin. Bar = 50 μm .

forming the felt of pilear surface, 50-70 μm thick, macroscopically seen as a brownish to blackish line, consisting of thick-walled, yellowish to brownish hyphae arranged very intricately and appearing as if embedded in a resinous substance; from this layer hair hyphae protrude forming a tomentum. Hair hyphae thick-walled, aseptate, 4-5 μm diam, yellowish to light brown. 2) Lower, context layer, to 250 μm thick, formed by clamped, hyaline, branched, thin to thick-walled, non-gelatinized, generative hyphae, 4-9 μm diam. Hyphal system monomitic but apparently dimitic (pseudodimitic) because of the presence of tramal, encrusted skeletocystidia, the latter scarce to numerous in the trama. Marginal hairs formed by finely encrusted skeletocystidia, appearing white due to crystals in the middle to apical portion of the hyphae; hyphae thick-walled, aseptate but secondary septa present, the walls developing a distinct greyish blue coloration in Melzer's reagent. No hyphae reacting in sulfovanilline.

Euhymenium present, up to 125 μm thick. Basidia claviform, 80-110 x 18-20 μm , with 4 sterigmata. Basidiospores ellipsoid, 17-24 x 12-15 μm , with slightly thickened, smooth, IKI- walls. Metuloids as hymenial to subhymenial cystidia abundant, mostly cylindric but some subulate, encrusted in the apex, with thickened walls, 5-10 μm diam. apically, narrower at the base, 65-85 μm long, not protruding beyond the hymenium. Gloeocystidia subulate, apically diverticulate or not, sulfonegative, with or without oily-like contents, with thin to thick, hyaline walls, 90-110 x 6-15 μm . Dendrohyphidia or dendrophysoid structures lacking.

Habitat: saprophytic, growing on *Polylepis australis* on: a) the external layers of rhytidome of thin, living branchlets and b) the sheath formed by the stipules fused around the branch of clustered and dead leaves. Fruiting in spring.

Associated wood-rot white.

Material studied: Argentina, Córdoba, Depto. Punilla, Parque Nacional Quebrada del Condorito, leg. G.L. Robledo 267, 6.Sep.2004 (Holotype CORD). Ibid., leg. Menoyo & Becerra, s.n., 17.May.2004 (CORD). Ibid., Los Gigantes, Quebrada de Anselmo, leg. G.L. Robledo s.n., 26.Jun.2004 (CORD). Depto. San Alberto, Los Gigantes, Quebrada Nipur, leg. G.L. Robledo 380, 8.Feb.2005, 31° 24' 41" W 64° 48' 26" S.

Additional material studied. *Aleurocystis magnispora*, Colombia, Cundinamarca, km 20 road from Mosquera to La Mesa, 2300 masl, leg. L. Ryvarden 15573, 6.Jun.1978 (O).

Discussion

The cupuloid-discoïd basidiome, large, non-amyloid basidiospores, metuloids, and clamped, thick-walled hyphae in the trama warrant the inclusion of this taxon in *Aleurocystis* G. Cunn. (Cunningham 1956, 1963; Ryvarden 1998). The species is characterized by the presence of hymenial, sulfonegative gloeocystidia, finely encrusted skeletocystidia whose walls turn greyish blue in IKI, the lack of dendrohyphidia in the hymenium, and the plant host. Two species are currently accepted in the genus (Parmasto 1997, Ryvarden 1998). *Aleurocystis habgallae* (Berk. & Broome) G. Cunn., the type species, differs from *A. gloeocystidiata* by fusiform to conic, metuloid cystidia, subglobose to broadly oval basidiospores, dendrohyphidia, and the formation of a conidial stage with globose spores; it probably has a pantropical distribution (Cooke 1951, Cunningham 1963, Hjortstam & Larsson 1995). *Aleurocystis magnispora* (Burt) P.A. Lemke differs in its broadly attached (i.e., stereoid) basidiocarp, with several units

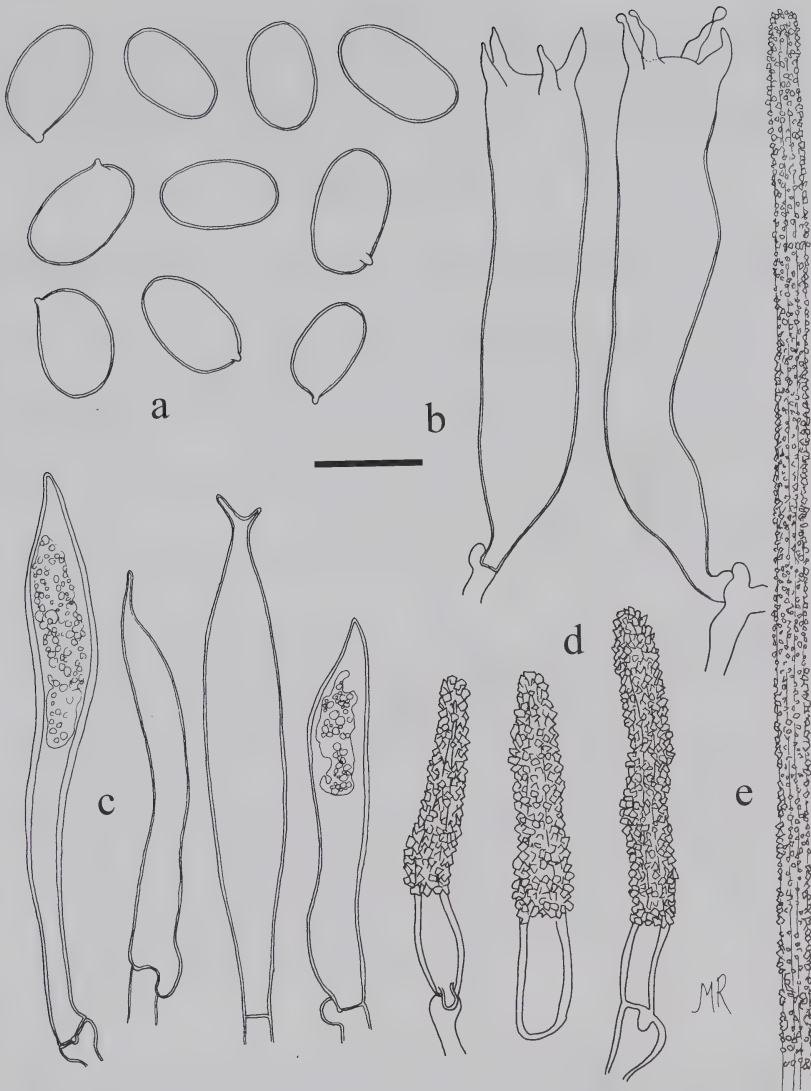


Fig. 5. *Aleurocystis gloeocystidiata* (Robledo 267, holotype), microscopic features: a, basidiospores. b, basidia. c, gloeocystidia. d, metuloids. e, incrusting skeletocystidia from the margin.

Bar = 20 μm .

coalescing and forming a relatively large basidiome (i.e., several cm wide), coarsely encrusted, subulate to conic metuloid cystidia, and dendrohyphidia; it has a neotropical distribution being recorded from Jamaica, Colombia and southern Brazil (Welden 1958, Lemke 1964, Hjortstam & Larsson 1995, Ryvarden 1998).

Acknowledgements

We thank Prof. L. Ryvarden the loan of critical material. Dr. K. Hjörtstam and Dr. P.K. Buchanan critically reviewed the article and offered valuable suggestions to improve it. We also acknowledge the Volkswagen Foundation and Agencia Córdoba Ciencia for financial support and Administración de Parques Nacionales (APN) for working permits. MR and GLR are researcher and fellow, respectively, of the National Research Council of Argentina (CONICET).

Literature cited

- Cooke W.B. 1951. The genus *Cytidia*. *Mycologia* 43: 196–210.
- Cunningham G.H. 1956. Thelephoraceae of New Zealand III: the genus *Corticium*. *Transactions of the Royal Society of New Zealand* 82: 271–327.
- Cunningham G.H. 1963. The *Thelephoraceae* of Australia and New Zealand. *New Zealand Department of Scientific and Industrial Research Bulletin* 145: 1–359.
- Fjeldså J. & Kessler M. 1996. Conserving the biological diversity of *Polylepis* woodlands of the Highland of Peru and Bolivia. A contribution to sustainable natural resource management in the Andes. Copenhagen, Denmark: NORDECO, 250 p.
- Hjörtstam K. & Larsson K.-H. 1995. Annotated check-list to genera and species of corticioid fungi (*Aphylliphorales*, Basidiomycotina) with special regards to tropical and subtropical areas. *Windahlia* 21: 1–75.
- Lemke P.A. 1964. The genus *Aleurodiscus* (sensu lato) in North America. *Canadian Journal of Botany* 42: 723–768.
- Parmasto E. 1997. Cortbase, a nomenclatural taxabase of corticioid fungi (Hymenomycetes). *Mycotaxon* 61: 467–471.
- Robledo G., Urcelay C. & Rajchenberg M. 2003. New species causing decay on living *Polylepis australis* in Córdoba, central Argentina. *Mycologia* 95: 347–353.
- Ryvarden L. 1998. The genus *Aleurocystis*. *Cryptogamie mycologie* 19: 93–97.
- Simpson B. 1979. A revision of the genus *Polylepis* (*Rosaceae*, *Sanguisorbeae*). *Smithsonian Contributions in Botany* 43: 1–62.
- Urcelay C., Robledo G. & Rajchenberg M. 2000. *Phellinus tabaquilio* sp. nov. from Córdoba Mountains, Central Argentina. *Mycotaxon* 76: 287–291.
- Welden A.L. 1958. Two unrecognized species of *Cytidia*. *Mycologia* 50: 304–306.

Noteworthy microfungi from air samples

ANALIE A. FERNANDO¹, SUSAN E. ANAGNOST^{*1}, SHANNON R. MOREY², SHUANG ZHOU¹, CATHARINE M. CATRANIS³ & C.J.K. WANG⁴

**Corresponding author: seanagno@esf.edu*

¹Faculty of Wood Products Engineering, State University of New York
College of Environmental Science and Forestry, Syracuse, NY 13210 USA

²Roswell Park Cancer Inst, Elm and Carlton Streets, Buffalo, NY 14263 USA

³American Type Culture Collection

10801 University Blvd., Manassas, VA 20110 USA

⁴Faculty of Environmental and Forest Biology, State University of New York
College of Environmental Science and Forestry, Syracuse, NY 13210 USA

Abstract—Nine infrequently reported microfungi, including two ascomycetes and seven hyphomycetes, were among approximately 161 others obtained from air samples collected both indoors and outdoors from 103 homes in Syracuse, NY. *Acrodontium myxomyceticola* was one of the most common species encountered. This species and *Acremonium roseolum* were the most frequent representatives of their respective genera. *Acrodontium intermissum*, *Cladosporium macrocarpum*, *Gnomonia* sp., and *Myxotrichum deflexum* were recovered from several homes. *Aphanocladium album*, *Phialophora botulisporea*, and *Tetracoccusporium paxianum* were each represented by a single isolate. The high numbers of isolates of *A. myxomyceticola* may have been obtained in part because of the Random-50 approach to isolating fungi from Andersen air impaction plates. *Acrodontium myxomyceticola* and *T. paxianum* are new records for North America and for air samples; *A. roseolum* is a new record for air samples.

Key words—bioaerosols, hyaline and dematiaceous fungi, aeromycology

Introduction

This paper describes nine infrequently reported microfungi from air samples that were obtained as part of the Accurate Exposure Assessment for Bioaerosols in Indoor Environments (ACCURATE) and Assessment of Urban Dwellings for Indoor Toxics (AUDIT) programs at SUNY College of Environmental Science and Forestry (SUNY-ESF) and SUNY-Upstate Medical University, respectively (Environmental Protection Agency Project No. R-82860501-0). The AUDIT study surveyed environmental variables, including bioaerosols, and house characteristics of 103 homes of infants selected with the criterion of an expectant mother with asthma (Abraham et al. 2004). In addition, complete medical records from birth to age one were obtained for the infant cohort. Eight of the fungi reported here were among the 170 taxa (14,565 isolates)

recovered during 147 sampling visits to the 103 test homes (included 44 seasonal repeat visits). The remaining one isolate was retrieved during instrument testing performed at SUNY-ESF before the actual collections were conducted.

Among the numerous species of microfungi from both indoor and outdoor air environments, *Cladosporium* and *Penicillium* are consistently the two most commonly identified and prevalent taxa (Oren & Baker 1970, Maggi et al. 2000, Shelton et al. 2002, Kemp et al. 2003, Meklin et al. 2003). Other fungi that are also commonly reported but not as consistently include *Alternaria*, *Aspergillus*, *Oidiodendron*, and yeasts. Still others have been reported with much less frequency. One objective of the ACCURATE and AUDIT studies was to do as complete a survey of fungi in the test homes as possible. In order to comprehensively and systematically recover the fungi, the Random-50 method (Catranis et al. 2003) was designed to collect fungi from Andersen N6 sampler collection plates. This method also allowed the emergence of slower-growing fungi with less competition from fast-spreading colonies. The objective of this report was to describe some of the unusual microfungi collected and identified from the study homes using the Random-50 method.

Materials and Methods

Samples were collected during 147 sampling visits to 103 homes over a period of 16 months. At each visit five air samples were collected, three indoor and two outdoor, at specified sampling times over a two-day period. Petri plates with 3% malt agar (3% malt extract, 1% agar) were exposed in the Andersen single stage sampler for 3 or 6 min at 28 L/min. Agar plugs, representing fifty randomly selected points out of the 400 impaction points from each plate exposed in the Andersen sampler were transferred onto five 3% malt agar plates (10 per plate) and incubated at 22-24°C (Catranis et al. 2003, Catranis et al. in press). Hereafter, this technique is designated as "Random-50" in this paper. Microscope slide preparations were made from individual colonies that appeared in the Random-50 plates and from the original plates if the fungal counts were less than 5 from the Random-50 plates. Provisional identification of each fungus was based on microscopic as well as cultural characteristics. Subcultures of many isolates on 2% malt agar (2% malt extract, 1.5% agar, designated as "MA") plates and tubes were made for detailed study and identification. Procedures for the identification of isolates to genera and species followed the methods in Wang (1990). Each fungus was center-inoculated in 90 mm diam Petri dishes containing one of several media pertinent for its identification.

Photographs of colonies were from center-inoculated MA plates, and Bacto potato dextrose agar (designated as "PD"). A round piece of black paper was placed underneath the Petri dish for enhancing the appearance of pale cultures. Prints of cultures on Petri dishes were reduced to $\frac{3}{4}$ of original size. Micrographs of fungi were obtained with a Spot digital camera (Diagnostic Instruments) attached to a Nikon Eclipse E-600 microscope using brightfield, phase-contrast or Nomarski differential interference contrast microscopy (designated as "DIC"), or a Zeiss microscope (phase-contrast) and a SLR camera. Semi-permanent slides and stock cultures were deposited in the Mycology lab, SUNY-ESF.

Taxonomy

Acremonium roseolum (G. Sm.) W. Gams, 1971, *Cephalosporium-artige Schimmelpilze* (Hyphomycetes), 68–70.

≡ *Paecilomyces roseolus* G. Sm., 1962, Trans. Brit. Mycol. Soc. 45: 388 (Basionym).

Fig. 1

Description: Colonies on MA measuring 17–40 mm diam in 2 weeks, powdery, zonate, cream to very pale pink, some isolates with submerged margins; on Bacto Czapek-Dox agar thin, submerged growth measuring up to 60 mm diam, sparse aerial growth powdery, cream color; on PD, 40 mm diam in 2 weeks, floccose, white, center powdery to granular due to heavy sporulation, cream to pale pink. Mycelia hyaline. Conidiophores absent or occasionally arising as short branches from prostrate hyphae. Conidiogenous cells phialidic, phialides slender, gradually tapering from half the length to the apex, 27–35 (–45) μm long, 2.5–3.0 μm at the base, 1.0 μm at the apex. Conidia non-septate, limoniform, hyaline, smooth, 6–8 x 2–3 μm , in long chains.

Cultures Studied: USA. NY, Syracuse: ex indoor air sample, 90B-4, 7 Aug 2002, by A. Fernando; ex outdoor air sample, 97A-106, 4 Sep 2002, by S.R. Morey, and 34 additional isolates. A total of 36 isolates (17 from indoor samples, 19 from outdoor samples) were obtained from 18 homes, i.e., 17% of the homes. Two homes yielded the highest number of isolates. Six isolates (3 from indoor, 3 from outdoor samples) were from home 132A, and 6 isolates (1 from indoor, 5 from outdoor samples) were reported from home 39B. All 36 isolates were recovered in 2001: 2 in July, 23 in August, 10 in September, and 1 in October.

Remarks: *Acremonium roseolum* is rarely reported in the literature. Smith (1961) described it as *Paecilomyces roseolus* isolated by J. Webster, from dead stems of *Dactylis glomerata* L. (orchard grass), United Kingdom. Freire et al. (1999) reported *A. roseolum* from dwarf Brazilian cashew nuts in Brazil. *Acremonium roseolum* was recovered from soil collected 2 m from the shore of Mono Lake, California (Steiman et al. 2004). In the present study, it was the most frequently isolated *Acremonium* from 18 homes (17% of the homes). *Dactylis glomerata* is a very common weed in fields and along roadsides in the Syracuse, NY and central NY area. However, the connection between the presence of *A. roseolum* and *D. glomerata* has not been investigated.

Acrodontium intermisum de Hoog & V.G. Rao, 1975, Persoonia 8: 207–209.

Description: Colonies on 3% malt agar slow-growing, 10 mm diam in 3 weeks, velvety, wrinkled, light tan with restricted margin. Mycelial mass tan to orange-brown, tightly matted. Aerial hyphae much branched, subhyaline, some becoming conidiogenous cells. Conidiogenous cells distinct, indeterminate, tapering to produce a conidiogenous rachis, 40–62 x 1–2 μm , bearing a series of swollen conidiogenous nodes. Conidigenous nodes, 1.2–2.0 μm diam, sympodial. Conidia produced from many loci on the node, hyaline to subhyaline, 1-celled, smooth, obovoid to oblong, 3.0–3.5 x 2.0 μm ; after conidium secession, short denticle visible on the conidiogenous node.

Colony and microscopic structures were illustrated in Wang (1990).

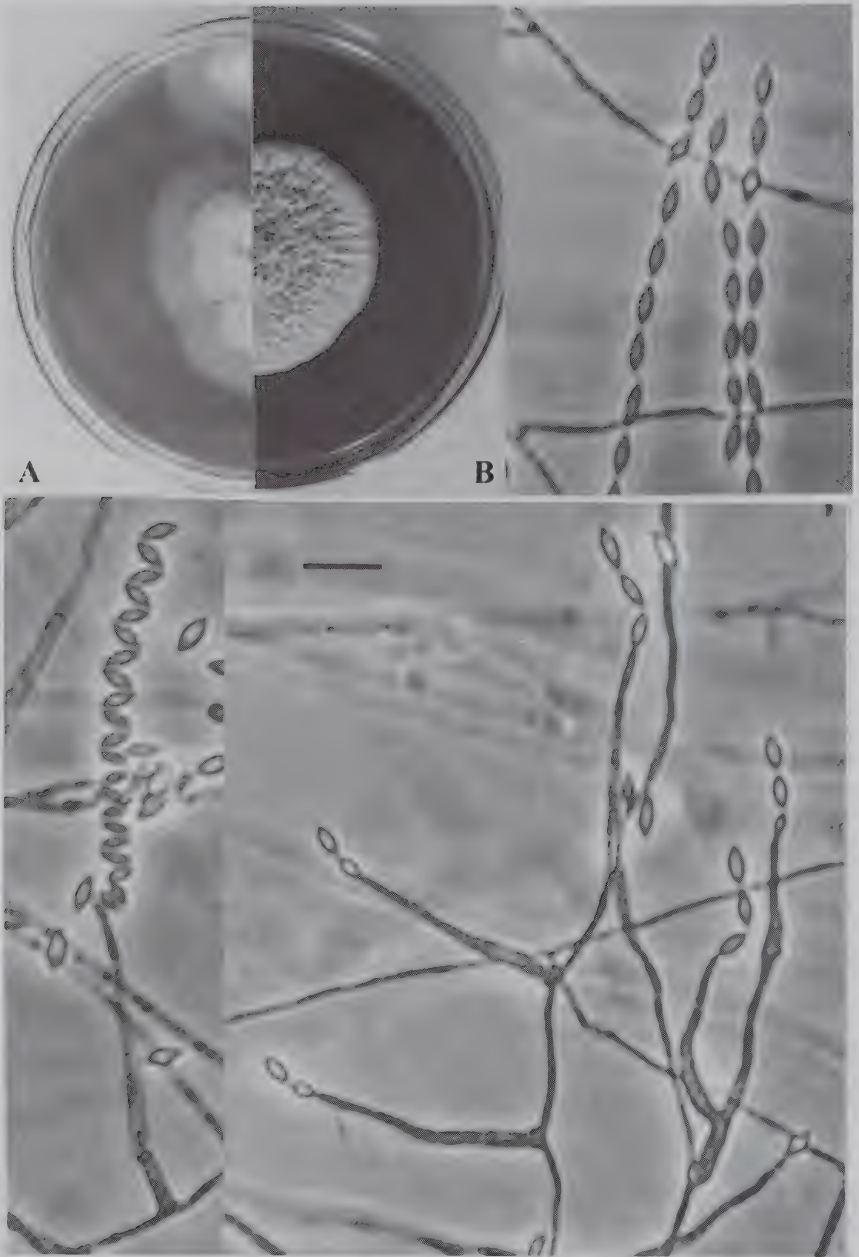


Fig. 1. *Acremonium roseolum*, 90B-4. Colonies; phialides and conidia, phase contrast, x1000. A. Colony on MA, black background, 2 weeks. B. Colony on PD, black background, 2 weeks. Bar=10µm.

Cultures studied: USA. NY, Syracuse: ex indoor air sample, 18A-60, 19 Dec 2001, by S.R. Morey; ex indoor air sample, 19B-153, 4 Jan 2002, by S.R. Morey, and 11 additional isolates. Twelve isolates were recovered from one home in December 2001. Of the 12 isolates, 4 were from indoor samples and 8 were from outdoor samples. A single isolate was recovered from an indoor sample in January 2002.

Remarks: The characteristics of isolates agreed with the descriptions by de Hoog & Rao (1970) and Wang (1990). However, conidia of the present isolates were mostly obovoid, whereas those from the utility poles were mostly oblong (Wang 1990). This extremely slow-growing fungus was recovered from two homes where the total fungal colony counts and the number of fast-spreading fungi were extremely low. Although *Acrodontium intermissum* was isolated from several creosote-treated southern yellow pine utility poles in New York and New Jersey (Wang 1990), this fungus was not a soft rotter (Wang & Worrall 1992). Piirto et al. (1998) investigated the fire-pathogen interactions in the *Sequoia gigantea* ecosystem in California and reported that *Acrodontium intermissum* was recovered from 22 out of 99 fire scars of the giant sequoia.

Acrodontium myxomyceticola J.L. Crane & Schokn., 1982, Trans. Br. Mycol. Soc. 79: 345-347. Fig. 2

Description: Colonies on MA 41-53 mm diam in 3 weeks, appressed, moist and waxy or pulverulent-tufted, white to yellowish cream. Conidiophores micronematous or semi-macronematous, hyaline, simple or branched, straight or flexuous. Conidiogenous cells hyaline, tapering towards the tip, sympodial denticulate rachis, indeterminate in length. Conidia non-septate, hyaline, smooth, obovoid or pyriform to naviculate, 3.0-5.0 (-6.0) x 1.8-2.0 (-3.0) μm .

Cultures studied: USA. NY, Syracuse: ex indoor air sample, 6A2-10, 15 Jul 2002, by A. Fernando; ex outdoor air sample, 109A-102, 30 Sep 2002, by A. Fernando, and 171 additional isolates, 89 from indoor air and 82 from outdoor air. *Acrodontium myxomyceticola* was isolated from 41 residences. Except for one isolate that was retrieved 8 May 2002 from indoor air, all of the rest were isolated from 9 Jul to 11 Oct 2002.

Remarks: *Acrodontium* spp. (including *A. intermissum*) were the 4th most frequently isolated fungi that were determined at least to the genus level, more than all *Alternaria* species combined. *Acrodontium myxomyceticola* composed 83% of all *Acrodontium* spp. isolated. As far as we are aware it has not been reported in the literature after its first collection from Brazil in association with the sporangia of *Stemonitis fusca* Roth. (Crane & Schoknecht 1982).

Aphanocladium album (Preuss) W. Gams, 1971, *Cephalosporium-artige Schimmelpilze* (Hyphomycetes), 196. Fig. 3

Description: Colonies on MA at 22-24°C, 57-64 mm diam in two weeks, white, floccose with pale red pigment diffused in agar; on PD at 22-24°C, 57-59 mm diam in 11 d, cream color, no diffused pigment; on PD at 33°C, 18-20 mm diam in 18 d. Conidiophores absent or occasionally present, one-celled, branched from the prostrate hyphae. Conidiogenous cells phialidic, phialides hyaline, solitary, occasionally in

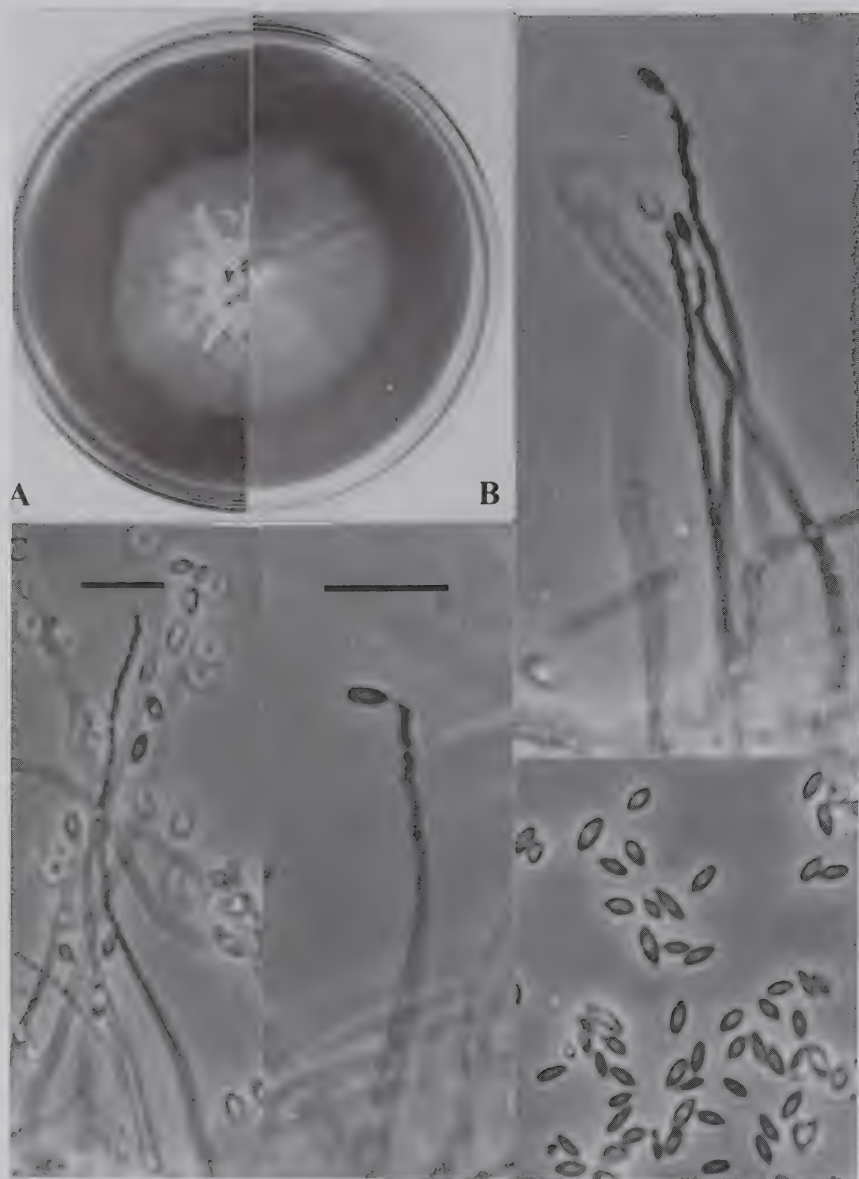


Fig. 2. *Acrodontium myxomyceticola*. Colonies; conidiogenous cells and conidia, 24A2-205, phase contrast illumination. X1500 except C. X1000. A. Colony on MA, black background, 3 weeks, 24A2-205. B. Colony on MA, black background, 3 weeks, 90B-202. Bars=10 μ m.



Fig. 3. *Aphanocladium album*, AIC. Colonies; phialides and conidia, phase contrast illumination, X1000. A. Colony on MA, black background, 2 weeks. B. Colony on PD, black background, 11 days. Bar=10 μ m.

whorls of 2-3, arising at right angles, 5-7 μm long with base swollen to 1.2-1.5 μm wide, thread-like after conidium secession. Conidia hyaline, ellipsoidal to obovoid with slightly pointed ends, 3.0-4.0 (-4.8) $\times$ 1.5-2.0 μm .

Culture studied: USA. NY, Syracuse: ex indoor air sample, A1C, Nov 2001, by S. Zhou. *Aphanocladium album* was isolated once during instrument testing performed at 424 Illick Hall, SUNY-ESF.

Remarks: *Aphanocladium album* has been reported as a hyperparasite of wheat rust, *Puccinia graminis* var. *tritici*, and to secrete chitinase. Great variations in morphology of conidiogenous cells and conidia have been noted by Gams et al. (1998). *Aphanocladium album* closely resembles *A. araneum* (Petch) W. Gams in the morphology of phialides and conidia, except that the phialides in *A. araneum* were often in whorls (Gams et al. 1998). Molecular study of these two species and several species from *Verticillium* section *Prostrata* by Zare and Gams (2001) revealed that *A. araneum* was closely related to *Lecanicillium psalliotae*, and it was renamed as *L. aphanocladii* Zare & W. Gams. *Lecanicillium aphanocladii* has no growth at 33°C on PD, whereas our isolate, A1C, has growth of 18-20 mm after 18 days at 33°C.

Cladosporium macrocarpum Preuss, 1848, in Sturm's Deut. Fl., 3: 27-28. Fig. 4

Description: Colonies on MA reaching 24-29 mm diam in two weeks, woolly, gray to grayish-green with whitish margin, reverse darker. Conidiophores macronematous, geniculate, nodose. Conidia 1-3-celled but mostly with 1 or 2 cells, olivaceous, subglobose, oval, ovate, ellipsoid, or limoniform, verrucose, with distinct hila, 12.5-7.5 $\times$ 7.5-10.0 μm , usually in short chains.

Cultures studied: USA. NY, Syracuse: ex outdoor air sample, 3A-210S, 12 Feb 2002, by A. Fernando, and 3 additional isolates from outdoor samples. In this study *C. macrocarpum* was isolated from 3 different residences on 12 February, 11 June, and 16 July 2002.

Remarks: *Cladosporium macrocarpum* is a common cosmopolitan species that is especially abundant on dead plants in temperate regions (Ellis 1971). In the present study it was considered uncommon, having constituted only 0.14% of the total *Cladosporium* isolates. In another study involving airborne fungal spores where *C. macrocarpum* was specifically counted, it comprised only 0.5% of the total *Cladosporium* isolates reported (Maggi et al. 2000). This species is allied to *C. herbarum* but has broader, more verrucose conidia with up to 3 septa (Ellis 1971, Morgan-Jones & Jacobsen 1988). *Cladosporium herbarum*, a frequent air sample isolate, made up 17% of the total *Cladosporium* isolates in this study.

***Gnomonia* sp.** Ces. & de Not., 1863, Schema Sferiac ital.: 57.

Fig. 5

Description: Colonies on MA slow-growing, reaching 16-27 mm diam in three weeks, appressed tufted to woolly, grayish-white to olivaceous, reverse cream to olivaceous. Perithecia olivaceous green to black, globose, 310-480 μm diam; beak central, straight or curved, 510 μm to more than 1 mm long, black and becoming lighter at tip, 40-65 μm wide at base tapering to 20-38 μm near apex. Asci hyaline, ellipsoid-fusoid, with stipe,

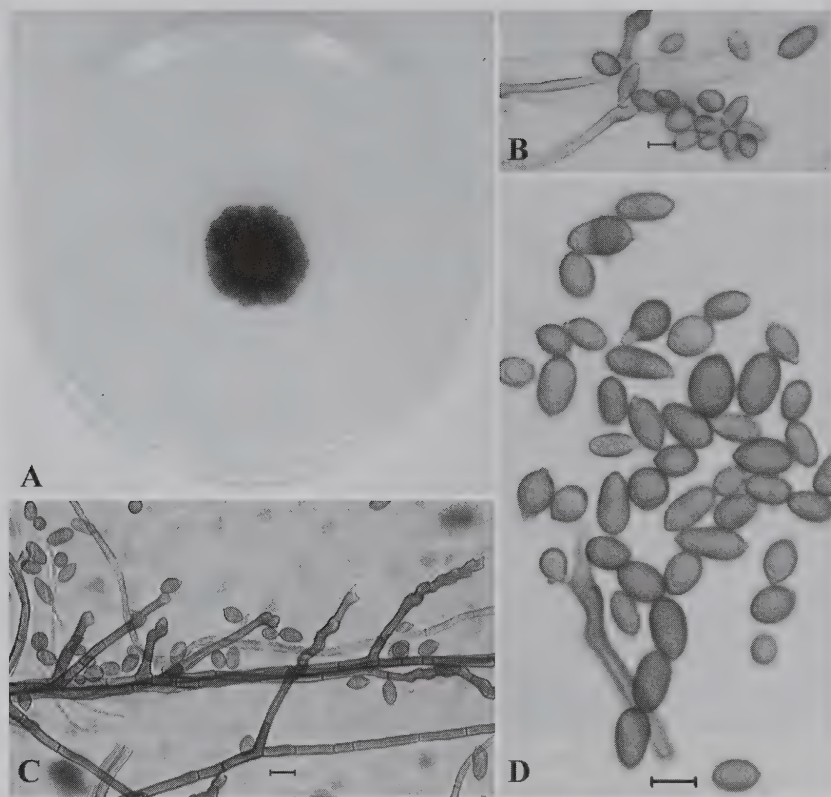


Fig. 4. *Cladosporium macrocarpum*, 3A-210s. A. Colony on MA, 2 weeks. B-D. Conidiophores and conidia: B & D, Nomarski DIC; C, brightfield illumination. Bars=10 μ m.

22.5-31.0 x 3.0-5.0 μ m, 8-spored. Ascospores hyaline, 1-septate ($\pm$ median), fusiform, slightly curved, (14-) 17-20 x 1 μ m, in a spindle-shaped fascicle in the ascus.

Cultures studied: USA, NY, Syracuse: ex indoor air samples, 87A-166X, 25 Apr 2002, 96B-162X, 14 May 2002, by A. Fernando, and 5 other isolates. In this study *Gnomonia* sp. was isolated from two residences on 25 Apr and 13, 14 May 2002.

Remarks: Descriptions of *Gnomonia* and its allied genera are presented in Barr (1978) and Monod (1983). According to Barr (1978), these fungi are usually saprobic, with a few parasitic species, in leaves and stalks of deciduous trees and shrubs, and herbaceous plants. The ascospores of *Gnomonia* isolates in this study resemble those of *G. quercus-borealis* but their size range better fits those of *G. gnomon* (Monod 1983). Ascospores that resembled those of *G. vulgaris* (syn *G. gnomon*) were retrieved in high numbers from outdoor air after a storm in England (Allitt 2000). Cultures studied produced fruiting bodies only after about 8-10 months on MA at room temperature. Morgan-Jones (1959) reported that *Gnomonia* spp. fruited rapidly and abundantly on Leonian's agar, at 18°C.

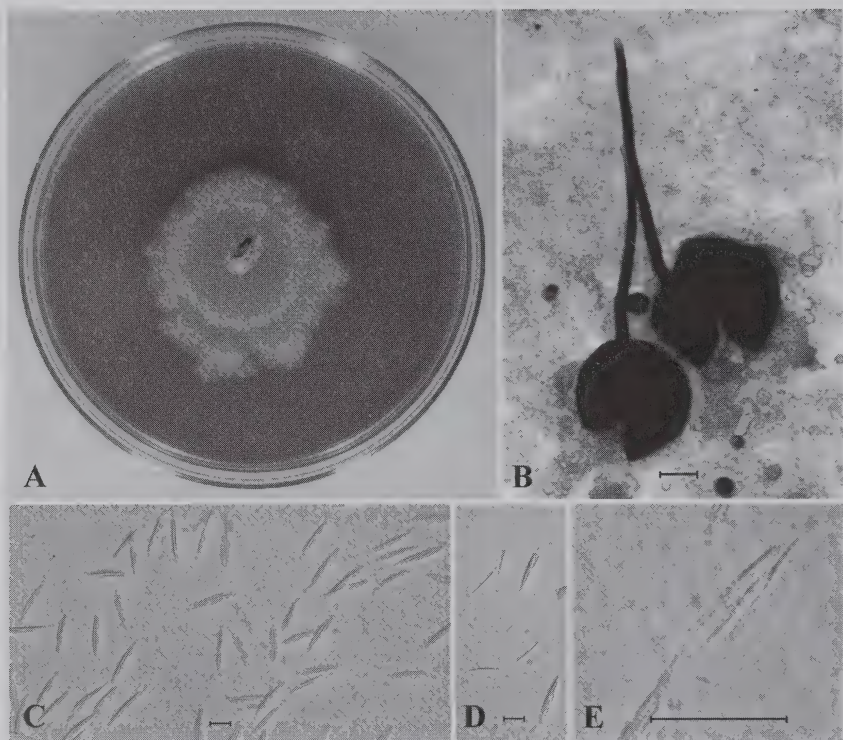


Fig. 5. *Gnomonia* sp. A. Colony on MA, black background, 8 weeks, 96B-38x. B. Perithecia, brightfield illumination, bar=100µm. C & D. Asci and ascospores, Nomarski DIC, bars=10µm. B-D, 87A-166x. E. Ascospores, Nomarski DIC, bars=10µm, 96B-162x.

***Myxotrichum deflexum* Berk., 1838, Ann. Nat. Hist. 1: 260.**

Fig. 6

Description: Colonies on MA slow growing, 17-25 mm diam in three weeks, subfelty-floccose to woolly, grayish white to reddish brown, reverse hyaline to dark rose pink, diffused rose pigment on agar. Ascomata globose, covered by much-branched appendages. Appendages dark brown, monopodially branched, lateral branches straight or deflexed upward or downward, borne along almost the entire length of the appendage, with hyaline apices. Asci hyaline, subglobose to pyriform or clavate, 12.0-16.0 x 7.5-9.0 µm, 8-spored. Ascospores hyaline, ellipsoidal, 3.5-4.5 x 2.0-3.0 µm.

Cultures studied: USA. NY, Syracuse: ex indoor air samples, 19B-1, 3 Jan 2002, 32B-153, 13 Mar 2002, by A. Fernando, and 4 additional isolates. In this study *M. deflexum* was isolated from four residences from 3 Jan to 4 Apr 2002.

Remarks: The characteristics of *M. deflexum* isolates agree with the descriptions reported by Orr et al. (1963) and Currah (1985). This fungus was earlier recorded from Argentina, Canada, England, France, Israel, USA (CA, ME, MA) on paper, plaster board, rotting board, rotten straw, rotten rug, feathers, fingernails, sand, soil, cow dung, wood, wood shavings, and ringworm lesions on a dog (Orr et al. 1963, Currah 1985).

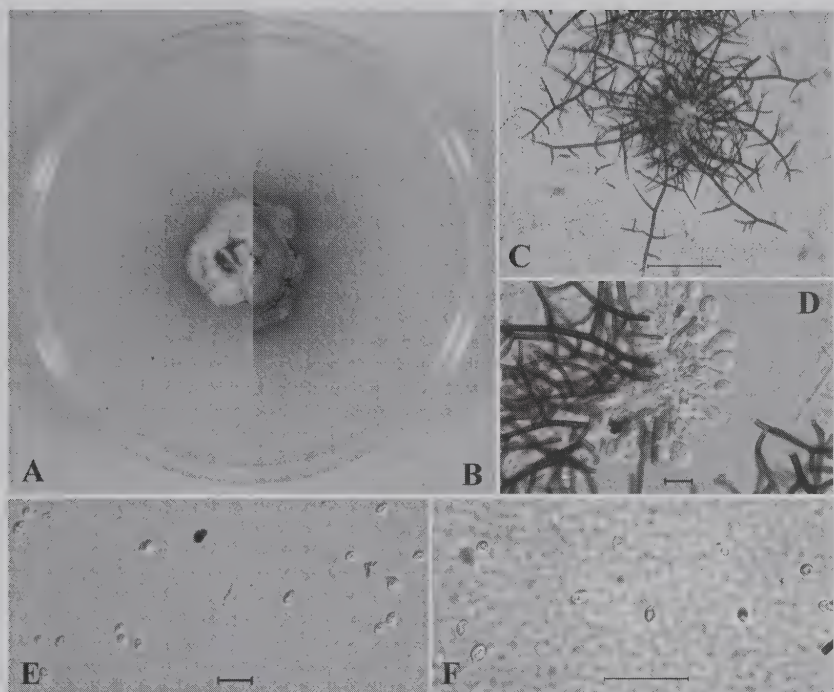


Fig. 6. *Myxotrichum deflexum*. A. Colony on MA, 3 weeks, 19B-51. B. Colony on MA, 8 weeks. C. Ascoma, brightfield illumination, bar=50 μ m. B & C, 19B-1. D. Asci, Nomarski DIC, bar=10 μ m. E & F. Ascospores, Nomarski DIC, bars=10 μ m. D-F, 32B-153.

Phialophora botulispora G.T. Cole & W.B. Kendr., 1973, *Mycologia* 65: 678.

Description: Colonies on MA 65 mm diam in 4 weeks, floccose grayish center and olivaceous black smooth edges. Mycelia form rope-like strands throughout the surface. Hyphae septate, ranging from light to dark brown. Conidiophores absent or semi-macronematous, brown, 16-20 (-24) μ m long, 4-5 μ m wide, many-branched and give rise to phialides. Phialides can arise singly from hyphae or more commonly from conidiophores, light brown, flask-shaped, with long collarettes, totaling 10-15 μ m in length and 2.5-4.0 μ m at widest part. Collarettes subhyaline to light brown, tubular, may be curved, 4-8 μ m long, 2 μ m wide. Conidia subhyaline, allantoid, non-septate, smooth, 3-6 x 1 μ m, sometimes seen inside collarettes and sometimes forming slimy masses at the tip of phialides.

Colony and microscopic structures were illustrated in Wang (1990).

Culture Studied: USA. NY, Syracuse: ex indoor air sample, 77A-184Xa, 14 Jun 2002, by S.R. Morey. In this study *P. botulispora* was isolated only once.

Remarks: The characteristics of the isolate agree with the descriptions published by Wang (1990). *Phialophora botulispora* is commonly known as a species that can cause

soft rot of wood and can be found in soil and vegetation. In the past this fungus was listed as having been isolated from both hardwood and coniferous species of trees (Cole & Kendrick 1973) and from pine utility poles (Wang 1990). More recent studies indicate a possible preference for conifers since this species was only isolated from spruce and not aspen (Lumley et al. 2001). Although *Phialophora* sp. has been previously reported from indoor air samples (Kowalski & Bahnfleth 1998), to our knowledge *P. botulispora* has never been specifically identified.

Tetracoccusporium paxianum Szabó, 1905, Hedwigia 44: 76-77.

Fig. 7

Description: Colonies on MA slow-growing, 25-40 mm diam in 4 weeks at 22-24°C, black, dry and not raised. Aerial mycelium gray, short, may appear sub-floccose around the inoculation point. Margin narrow, uneven, effuse or submerged. A black line may appear along the edge due to abundant sporulation. Hyphae septate, light greenish-black, 2-3 μm thick. Conidiophores absent or short, 1.7-3.5 (-10) μm , arising at right angles from the hyphae, rarely branched. Conidiogenous cells blastic, light greenish-black, smooth, ampulliform, may appear slightly flexuous, some with tapered ends, 2-6 (-8) μm . Conidia solitary, 4-celled, rarely more than 4 cells in older cultures, cruciately septate, light greenish-black and smooth when young, greenish-black and verrucose when mature, spherical or sub-spherical, 12-16 x 11-13 μm .

Culture studied: USA. NY, Syracuse: ex air sample, 29A-Z1, Feb 2002, by S. Zhou. In this study *T. paxianum* was isolated only once.

Remarks: This is the first report of *T. paxianum* in the USA. It has been reported from dung and soil in Europe and India (Ellis 1971) and air samples in Venezuela (<http://www.geog.umontreal.ca/aerobiol/myco/mycospora-gen-outdoor.htm>). Another species, *T. aerium*, was first isolated from air in India in 1975 (Misra & Srivastava 1976), and isolated in Mexico in 1991 (Heredia et al. 1995).

Discussion

The 147 sampling visits to homes of 103 infants yielded 14,565 isolates of bacteria, actinomycetes and fungi. A total of 12,456 isolates of fungi represented 170 fungal taxa. Many isolates (approximately 40%) have not yet been identified, or are unidentifiable: hyaline unknown fungi (3750), bacteria unknowns (948), dark (dematiaceous) unknown fungi (853), and basidiomycete unknown fungi (815). The most frequent, identifiable taxa were *Cladosporium cladosporioides* (1621), *Penicillium* spp. (908), *Cladosporium* spp. (610), *Aspergillus* spp. (606), and *Cladosporium herbarum* (377). *Acrodontium myxomyceticola* (173) was more frequent than *Alternaria* spp. (169).

The recovery of 173 isolates of *Acrodontium myxomyceticola* was significant, as it has not been reported in the literature of aeromycology. One culture, Wang 1169, *Acrodontium* sp. isolated from an air sample in Syracuse, New York by Chin S. Yang, September 15, 1982 is now identified as *A. myxomyceticola*. In this study *Acrodontium myxomyceticola* was a very common airborne fungus found both outdoors and indoors from 41 out of 103 homes (39.8%). The isolation technique, Random-50, by randomly

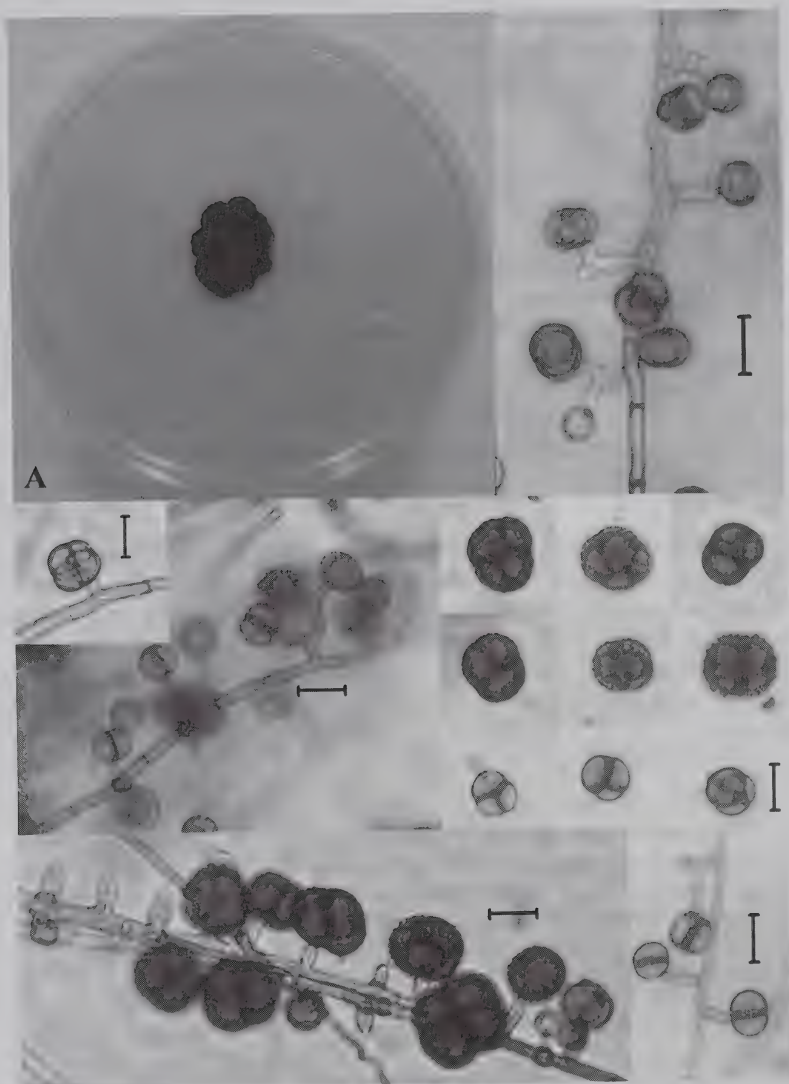


Fig. 7. *Tetracoccusporium paxianum*, 29A-Z1. Colony on MA, 2 weeks, conidiogenous cells, and conidia. Bars=10μm.

selecting 50 impaction points from the 400 very crowded impaction points on plates from the Andersen instrument allowed for the somewhat slower growth and eventual recovery of this fungus. Size and shape of the conidia could be another factor. Conidia of *Acrodontium myxomyceticola* measured 3-6 X 1.75-3 μm whereas those of the common *Alternaria alternata* measured 20-63 X 9-18 μm (Ellis 1971). Sampling efficiency was

shown to decrease as particle size increased when using the Andersen single stage sampler (Martinez et al. 1991). For particles of sizes 3, 5 and 10 μm , the recovery efficiency of the Andersen sampler was 90%, 71% and 11%, respectively (Martinez et al. 1991). This could be another reason that *A. myxomyceticola* was recovered more often (173 times) than the total *Alternaria* spp. (169 times).

Acronium roseolum was much more prevalent in August and September when pollen counts also increased. The possible correlation between the presence of conidia of *A. roseolum* and wheeze in infants will be analyzed. Likewise, *Acrodontium myxomyceticola* was common from July to October, and its possible effect on infants' health will also be investigated.

Acrodontium intermisum occurred in colder months when the fast-growing fungi and the total colony counts were low. This could have contributed to the rare report of this fungus. In this study, other slow-growing fungi, e.g., *Wallemia sebi*, *Stephanosporium cerealis*, *Myxotrichum deflexum* were also recovered from those homes with low fungal counts. The Random-50 method of subculturing from the original plates exposed with the Andersen sampler appears to have facilitated the isolation of these slow-growing fungi.

The development of the Random-50 sampling procedure (Catranis et al. 2003; Catranis et al. in press) most likely permitted the isolation of a larger number of fungi, especially rarely reported fungi, during the course of our study than may have been isolated using conventional methods.

This paper presents so far identifiable, rarely reported microfungi from air samples. Systematic work continues on the 170 taxa obtained from the AUDIT study homes, their associations to other environmental variables and house characteristics, as well as possible correlation to infant asthma.

Acknowledgments

This research was financed by the Environmental Protection Agency (EPA R-82860501-0), NYIEQ Center, Syracuse, NY, the Syracuse, NY Metropolitan Development Association and the New York State Education Department (Grant #C990871). We acknowledge Paula DeStefano, Christopher Garback, Melanie Lamoy, Judith Crawford, Andrew Hunt and Jerrold Abraham (Principal Investigator) of the AUDIT program at Upstate Medical University for sample collection. We are grateful to Dr. W.B. Kendrick, Mycologue Consultants, Sidney, British Columbia and Dr. R.S. Currah, University of Alberta for reviewing this manuscript, and for their valuable suggestions.

Literature cited

- Abraham JL, Crawford JA, Hall G, Hargrave T, Hunt A, Lane SD, Liu C, Naishadham D, Rosenbaum P, Anagnost SE. 2004. The Syracuse AUDIT Study: Risk factors for wheeze in the first year of life: Study design, characteristics, range of exposures, and preliminary analysis of outcomes. Abstract and poster presentation, Center of Excellence in Environmental Systems Symposium, Syracuse University, October 25 and 26, 2004. Allitt U. 2000. Airborne fungal spores and the thunderstorm of 24 June 1994. *Aerobiologia* 16: 397-406.
- Barr ME. 1978. The Diaporthales in North America with Emphasis on *Gnomonia* and its Segregates. *Mycologia Memoir* No. 7. J. Cramer Publisher, Germany.

- Catranis CM, Anagnost SE, Wang CJK, Zhang L, Fernando AA, Morey S, DeStefano P, Garback C, Lamoy M, Hall G, Crawford JA, Naishadham D, Hunt A, Abraham JL. 2003. Assessment of exposure to indoor environmental factors for an infant cohort at risk for asthma. Abstract 6th Conference on Bioaerosols, Saratoga Springs, New York, September 10-12, 2003.
- Catranis CM, Anagnost SE, Wang CJK, Zhang L, Fernando AA, Morey S, DeStefano P, Garback C, Lamoy M, Hall G, Crawford JA, Naishadham D, Hunt A, Abraham JL. Assessment of exposure to indoor environmental factors for an infant cohort at risk for asthma. Proceedings 6th Conference on Bioaerosols, Saratoga Springs, New York, September 10-12, 2003. In press.
- Cole GT, Kendrick B. 1973. Taxonomic studies of *Phialophora*. Mycologia 65: 661-688.
- Crane JL, Schoknecht JD. 1982. A new species of *Acrodontium* from Brazil. Trans. Br. Mycol. Soc. 79: 345-347.
- Currah RS. 1985. Taxonomy of the *Onygenales: Arthrodermataceae, Gymnoascaceae, Myxotrichaceae and Onygenaceae*. Mycotaxon 24: 1-216.
- De Hoog GS, Rao V. 1975. Some new Hyphomycetes. Persoonia 8: 207-212.
- Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
- Freire FCO, Kozakiewicz Z, Paterson RM. 1999. Mycoflora and mycotoxins of Brazilian cashew kernels. Mycopathologia 145: 95-103.
- Gams W, O'Donnell K, Schroers HJ, Christensen M. 1998. Generic classification of some more hyphomycetes with solitary conidia borne on phialides. Can. J. Bot. 76: 1570-1583.
- Heredia G, Sierra AM, Portales JM. 1995. Conidial fungi from leaf litter in a mesophilic cloud forest of Veracruz, Mexico. Mycotaxon 55: 473-490.
- Kemp PC, Neumeister-Kemp HG, Esposito B, Lysek G, Murray F. 2003. Changes in airborne fungi from the outdoors to indoor air; large HVAC systems in nonproblem buildings in two different climates. AIHA Journal 64: 269-275.
- Kowalski W, Bahnfleth WP. 1998. Airborne respiratory diseases and mechanical systems for control of microbes. HPAC Engineering 70: 34-48.
- Lumley TC, Gignac LD, Currah RS. 2001. Microfungus communities of white spruce and trembling aspen logs at different stages of decay in disturbed and undisturbed sites in the boreal mixedwood region of Alberta. Can. J. Bot. 79: 76-92.
- Maggi O, Persiani AM, Gallo F, Valenti P, Pasquariello G, Sclocchi MC, Scorrano M. 2000. Airborne fungal spores in dust present in archives: proposal for a detection method, new for archival materials. Aerobiologia 16: 429-434.
- Martinez KF, Todd WF, Fishbach TJ. 1991. Evaluation of Alternative Samplers for Bioaerosols, Phase 1: Physical Sampling Efficiency, Report No. CT-160-04A, National Institute for Occupational Safety and Health, Cincinnati, OH. 46 pp.
- Meklin T, Hyvarinen A, Toivola M, Reponen T, Koponen V, Husman T, Taskinen T, Korppi M, Nevalainen A. 2003. Effect of building frame and moisture damage on microbiological indoor air quality in school buildings. AIHA Journal 64: 108-116.
- Misra PC, Srivastava P. 1976. A new species of *Tetracoccusporium*. Mycotaxon 4: 276-278.
- Monod M. 1983. Monographie taxonomique des *Gnomoniaceae*. I. Beih. Sydowia 9: 1-315.
- Morgan-Jones JF. 1959. Morpho-cytological studies of the genus *Gnomonia*. III. Early stages of perithecial development. Svensk Bot. Tidskr. 53: 81-101.
- Morgan-Jones G, Jacobsen BJ. 1988. Notes on hyphomycetes. LVIII. Some dematiaceous taxa, including two undescribed species of *Cladosporium*, associated with biodeterioration of carpet, plaster and wallpaper. Mycotaxon 32: 223-236.

- Oren J, Baker GE. 1970. Molds in Manoa: A study of prevalent fungi in Hawaiian homes. *Annals of Allergy* 28: 472-481.
- Orr GF, Kuehn HH, Plunkett OA. 1963. The genus *Myxotrichum* Kunze. *Can. J. Bot.* 41: 1457-1480.
- Piirto DD, Parmeter Jr. JR, Cobb Jr. FW, Piper KL, Workinger AC, Orosina WJ. 1998. Biological and management implications of fire-pathogen interactions in the giant sequoia ecosystem. In: Fire in ecosystem management: shifting the paradigm from suppression to prescription. Tall Timber Fire Ecology Conference Proceedings No. 20. Tallahassee, Florida.
- Shelton BG, Kirkland KH, Flanders WD, Morris GK. 2002. Profiles of airborne fungi in buildings and outdoor environments in the United States. *Appl. and Env. Microbiology* 68: 1743-1753.
- Smith, G. 1962. Some new and interesting species of micro-fungi. III. *Trans. Brit. Mycol. Soc.* 45: 387-394.
- Steiman R, Ford L, Ducros V, La Fond JL, Guiraud P. 2004. First survey of fungi in hypersaline soil and water of Mono Lake area (California). *Antonie van Leeuwenhoek* 85: 69-83.
- Wang CJK. 1990. Microfungi, pp. 105-348. In: Wang CJK, Zabel, RA (Eds.). *Identification Manual for Fungi from Utility Poles in the Eastern United States*. American Type Culture Collection Publisher, VA.
- Wang CJK, Worrall JJ. 1992. Soft rot decay capabilities and interactions of fungi and bacteria from fumigated utility poles. Research Project 1471-03, Final Report. Electric Power Research Institute, TR-1012445. Palo Alto, California.
- Zare R, Gams W. 2001. A revision of *Verticillium* section *Prostrata* IV. *Nova Hedwigia* 73: 1-50.

What is *Oospora oryzetorum*?

WALTER GAMS¹ & AMY Y. ROSSMAN²

gams@cbs.knaw.nl arossman@nt.ars-grin.gov

¹*Centraalbureau voor Schimmeltcultures*

P.O. Box 85167, 3508 AD Utrecht, The Netherlands

²*Systematic Botany and Mycology Laboratory,*

USDA-ARS, Beltsville, MD 20705, USA

Abstract—*Oospora oryzetorum* was described in 1916 on rice glumes but has never been seen since then. Specimens labeled as this fungus all apparently from the original collection were examined. The only structures on these specimens that could be interpreted as this fungus are starch granules originating from the host. It is concluded that these structures of plant origin were mistakenly described as this fungus and that *Oospora oryzetorum* does not pose a threat to rice cultivation.

Key word—rice pathogen

Oospora oryzetorum Sacc. was described by Saccardo (1916, listed in Trotter, 1931) as consisting of a white powder covering dying glumes of young rice grains (*Oryza sativa* L.) in Los Baños, Philippines. The conidia were described as short-catenulate, globose, sometimes slightly angular or globose-ellipsoidal, 2.5–3.5 μm diam, hyaline, often 1-guttulate.

The disease attributed to *O. oryzetorum* apparently has not been observed since, but it was described in English words by Stevenson (1926, p. 125), with the same or similar words by Padwick (1950, p. 180), and Ou (1972, p. 316; 1985, p. 330): “This disease attacks the heads when they are near maturity, a whitish bloom spreading over the panicles. Diseased heads are largely blasted or destroyed.”

For many years Saccardo had included several acremonium-like fungi with catenate conidia in *Oospora* and therefore most of these species were revised by Gams (1971). Gams (l.c.) examined the material labeled *Oospora oryzetorum* distributed as C.F. Baker, Fungi Malayana No. 264, lodged in the herbaria in B, K, PAD and S. In none of them could he find fungal material that matched the meager description and therefore he concluded that the identity of the fungus could not be assessed.

Because of an interest by plant quarantine authorities, the second author started a reexamination of two further specimens of the same collection accessioned in BPI. In one of these (BPI 408511), originating from the herbarium of O. Reinking, some glumes showed a rather conspicuous white covering that seemed to match the diagnosis of this species. Upon closer examination, we observed only irregular masses of refringent,

more or less angular, hyaline bodies with a central dot, which are not fungal, rather they appear to be starch grains. It seems plausible that Saccardo (1916) mistook these structures for fungal conidia. On the BPI specimens a *Fusarium* was also present on some glumes, but the diagnosis in Saccardo (1916) does not allow confusion with a species of this genus. It similarly precludes confusion with the causal agent of sheath blotch in rice, *Saroeladium oryzae* (Sawada) W. Gams & D. Hawksw., which has much larger cylindrical conidia and was recently redescribed by Bills *et al.* (2004).

One must conclude that the description of *Oospora oryzae* as a fungus is erroneous. The supposed fungus appears to be of plant origin, most likely starch granules. All specimens represented by this name were examined and none of them contain fungal material that agrees with the type description. The scientific name *Oospora oryzae* should be ignored and, most certainly, does not constitute a threat to rice cultivation.

Specimens examined: PHILIPPINES: Laguna Province, Mt. Maquiling, near Los Baños, on *Oryza sativa*, Sep 1915, coll. C.F. Baker, Fungi Malayana 264 (Holotype: PAD; Isotypes: B, BPI 408510, BPI 408511, K, S).

Acknowledgements

Mary Palm is warmly thanked for her encouragement in this project as well as final review of the paper. Scott Redlin also has kindly provided a review and useful suggestions.

Literature cited

- Bills GF, Platas G, Gams W. 2004. Conspicuity of the cerulenin and helvolic acid producing '*Cephalosporium caerulens*', and the hypocrealean fungus *Saroeladium oryzae*. Mycol. Res. 108: 1291–1300.
- Gams W. 1971. Cephalosporium-artige Schimmelpilze (Hyphomycetes). G. Fischer, Stuttgart.
- Ou, SH. 1972. Rice Diseases. Commonwealth Mycological Institute, Kew, Surrey.
- Ou, SH. 1985. Rice Diseases, second edition. Commonwealth Mycological Institute, Kew, Surrey.
- Padwick GW. 1950. Manual of rice diseases. Commonwealth Mycological Institute, Kew, Surrey.
- Stevenson JA. 1926. Foreign Plant Diseases. U.S. Dep. Agric., Washington DC.
- Saccardo PA. 1916. Notae mycologicae XX. Nuovo G. bot. ital. 23: 185–234.
- Trotter A. 1931. Saccardo's Sylloge Fungorum, Vol. 25, Supplementum universale. Pergola, Abellini & R. Friedländer, Berlin.

MYCOTAXON

Volume 92, pp. 341–344

April–June 2005

New lichen records from Turkey

KENAN YAZICI*

kcagri_1997@yahoo.com

*Biology Department, Fatih Education Faculty, Karadeniz Technical University
Trabzon, Turkey*

ALI ASLAN

aliaslan@atauni.edu.tr

*Biology Department, Kazım Karabekir Education Faculty, Atatürk University
Erzurum, Turkey*

ANDRÉ APTROOT

aptroot@cbs.knaw.nl

*Adviesbureau voor Bryologie en Lichenologie
G. v. d. Veenstraat 107, NL-3762 XK Soest, The Netherlands*

Abstract—Four lichen species, *Adelolecia pilati*, *Dermatocarpon arnoldianum*, *Xanthoparmelia protomatrae* and *Verrucaria ochrostoma* are reported as new for the lichen flora of Turkey. For each, a short description is presented.

Key words—Ascomycetes, Bayburt, Erzurum, flora, MustafaKemalpaşa

Introduction

The lichen flora of Turkey is still very incompletely known and many regions of the country have yet to be investigated. In recent years there has been a substantial increase in lichenological investigation of this country (Aslan 2000, Aslan & Öztürk 1994, Aslan et al. 1998, 2002 ab, Gönülol et al. 1995, Öztürk & Kaynak 1999, Öztürk 1990, Özdemirtürk 2003, Yazıcı & Aslan 2002 ab, Yazıcı 1995, Yazıcı & Aslan 2003, Yazıcı et al. 2004). John (1996ab) compiled a catalogue of previous work and provided an invaluable checklist on which to build our knowledge. The present paper is a further contribution to the knowledge of the lichen flora of Turkey.

Material and methods

Samples were collected on three different stations, in Bayburt, Erzurum and Bursa provinces, in July–August 2003 and in June 2004. A stereo-microscope, a light-microscope and the usual spot tests were used in the identification of the samples, together with the following references: Clauzade & Roux (1985), Poelt (1974), Poelt

& Vězda (1981), Purvis et al. (1992) and Wirth (1995). Vouchers have been deposited in the herbarium of the Biology Department, Fatih Education Faculty, Karadeniz Technical University.

Results

Adelolecia pilati (Hepp) Hertel & Hafellner

Thallus crustose, of dark grey to whitish areoles, or $\pm$ immersed and scarcely apparent, often indefinite, with coccoid green algae. Apothecia 0.5-1.5(-2) mm diam., sessile, sometimes aggregated together and then angular, sometimes tuberculate, with narrow base, with proper margin, black. Excipulum of radiating hyphae, K+ purple-red or K-. Hypothecium colorless, pale brown to pale greenish. Hymenium colorless to slightly greenish, I+ blue. Epihymenium green. Paraphyses $\pm$ simple, strongly cemented. Asci *Biatora*-type, clavate-cylindrical; ascospores 1(-2) celled, (6-)8-11(-13) $\times$ (3-)3.5-5 μ m, colourless, narrowly ellipsoidal and lacking a distinct perispore. Lichen substances lacking or atranorin present. Thallus P-, K-, KC+ pink or KC-, C-; exiple K+ purple-red (2-chloroemodin); epithecium N+ purple-red.

Grows in high montane and arctic-alpine situations, usually on the upper surfaces of siliceous rock on rather rain-protected to moderately rain-exposed sloping surfaces, usually with very few accompanying species.

Known from Europe, Asia, and North America.

Erzurum: Palandöken Mountains, upper part of the Abdurrahman Gazi Tomb, on siliceous rock, at 2700 m, 39° 54' 00" N, 41° 17' 00" E, 28 June 2004, Aslan 1250.

Dermatocarpon arnoldianum Degel.

Thallus single-lobed, to c. 50 mm diam., often irregularly incised, rigid, 0.4-0.7 mm thick; upper surface greyish brown, not pruinose, green when wet; lower surface pale brown, roughened at first, later folded, veined and without rhizine; cells of upper cortex 8.5 μ m diam. Photobiont chlorococcoid. Ascomata perithecia; perithecia 0.25-0.45 mm diam., uniloculate, immersed, globose, involucrellum absent. True exciple colourless, reaching the surface by a short to rather long ostiolar neck. Hamathecium of numerous paraphyses; hymenial gel I+ blue. Asci *Verrucaria*-type, subcylindrical, thick-walled, K - and I -; ascospores 8 per ascus, 13-15 $\times$ 4.5-6.5 μ m, oblong-ellipsoid, colourless, smooth and without perispore. No lichen products have been detected.

Grows on hard acid or calcareous rocks on semi-inundated boulders in streams and at margins of upland lakes in cool temperate regions. Known from Europe and North America.

Bayburt: Yeniköy High Plateau, on calcareous rock, at 2550 m, 40° 03' 45" N, 40° 10' 10" E, 02 July 2003, Yazıcı, 1249.

Verrucaria ochrostoma (Borrer ex Leighton) Trevisan

Thallus distinctly superficial, without soredia, pale yellow-brown, grey, grey-brown or dark brown, aerolate; areoles 0.3-1.2 mm wide; 0.1-0.2 mm thick, flat or more commonly

convex, rounded or angular. Perithecia simple, entirely immersed in pits; involucrellum absent; apex 180-220 μm diam., convex, brown to black; centrum 0.3-0.4 mm diam, globose; true exciple brown-black often dense and brittle. Asci *Verrucaria*-type, clavate to elongate-ellipsoid with two distinct wall layers discharge often obscure; ascospores 8 per ascus, 18-23 x 8-12(-14) μm , subglobose to ellipsoid, colourless, thin-walled, smooth, non-septate. No lichen products have been detected.

Grows on mortar, brick, and other siliceous rock. Known from Europe and Asia.

Bursa: MustafaKemalpaşa, 5 km to Suuçtu Cascade, on siliceous rock, at 450 m, 39° 54' 45" N, 28° 21' 45" E, 26 August 2003, Yazıcı 1254.

Xanthoparmelia protomatrae (Gyeln.) Hale

Thallus foliose, $\pm$ extensive, usually not forming rosettes, not dying in the interior, often pale green-yellow to yellowish grey-green, smooth, without isidia, usually loosely attached. Lobes narrow, elongate, flattened, robust, usually shiny, often irregularly growing over one another, narrow to broad, upper surface often partially covered with black dots, undersurface brownish. Rhizines simple, abundant at margin. Medulla P+ orange-red, K+ dull brown, C-, KC-, UV -. Lichen substances fumarprotocetraric acid and usnic acid. Apothecia often lacking or very rare, plane, lecanorine, sessile, strongly constricted with margin distinct and disc brown. Ascospores 8 per ascus, 6-10 x 4-5 μm , simple, hyaline, ellipsoid. Photobiont chlorococcoid.

Grows on weathered siliceous rocks and mineral soil in open, dry situations. Known from Europe and Asia.

Erzurum: Palandöken Mountains, upper part of the Addurrahman Gazi Tomb, on soil, at 2700 m, 39° 54' 00" N, 41° 17' 00" E, 28 June 2004, Aslan 1248.

Discussion

This paper describes four new records for the lichen flora of Turkey. In previous work performed in the region, Yazıcı (1999a,b) reported 78 species, Yazıcı (1999b) 231, Yazıcı and Aslan (2003) 206, and Yazıcı et al. (2004) a total of 4 lichen species. The harshest climate of Turkey prevails in Erzurum. Spring is rainy, summer is hot and arid, and winter is cold and snowy. The plant cover of this province is scarce, mainly due to the destruction of the natural vegetation around residences and in agricultural areas. The major part is covered by steppe. Forest remnants are located in higher mountain areas. Tree genera include *Pinus*, *Picea*, *Fagus*, *Quercus*, *Juniperus*, *Abies*, and *Ulmus*, with coniferous trees predominating. Forested areas occur at altitudes between 700 and 2500 m. Erzurum is rich in crustose and foliose lichen species. Bayburt has a continental climate with severe winters and hot summers; it is quite poor in forest cover and fruticose lichen species but very rich in crustose lichens. The climate of MustafaKemalpaşa (Bursa) is mild and cool in summer, being intermediate between continental and cool Mediterranean. Below 400 m, the dominant vegetation type is macchia. However, between 400 and 700 m forest appears, especially along streams, and includes *Pinetum*, *Quercetum* and *Carpinetum*. Large areas have been converted into prairies. MustafaKemalpaşa is also rich in crustose lichen species.

Acknowledgments

We are grateful to Prof. Dr. Vagn Alstrup and Prof. Dr. John Elix for their linguistic revision and helpful comments on an earlier draft of this paper.

References

- Aslan A. 2000: Lichens from the Regions of Artvin, Erzurum and Kars (Turkey). *Israel Journal of Plant Sciences* 48:143-155.
- Aslan A, Öztürk S. 1994: Oltu (Erzurum) Yöresine Ait Liken Florası Üzerine Çalışmalar. *Doğa Turk Botanik Dergisi* 18:103-106 (in Turkish).
- Aslan A, Yazıcı K, Karagöz Y. 2002a: Lichen flora of the Murgul District (Artvin, Turkey). *Israel Journal of Plant Sciences* 50: 77-81
- Aslan A, Aptroot A, Yazıcı K. 2002b: New lichens from Turkey. *Mycotaxon* 84: 277-280.
- Aslan A, Öztürk A, Kaya E. 1998: Likenlerin ekonomik Önemi ve Oltu Bölgesinden Tesbit Edilen Önemli liken Türleri. *Geçmişten Geleceğe Oltu ve Çevresi Sempozyumu*, 1-3 Temmuz, Erzurum (in Turkish).
- Clauzade G, Roux C. 1985: Likenler de Okcidenta Europo.-Bulletin de la Société Botanique du Centre-Ouest, Nouvelle Série, No. Spécial 7. Rouen.
- Gönülol A, Kınalıoğlu K, Ergin A. 1995: Türkiye Liken Florası İçin Yeni Kayıtlar. *Turkish Journal of Botany* 19: 405-410.
- John V. 1996a: Preliminary catalogue of lichenized and lichenicolous fungi of Mediterranean Turkey. *Bocconea* 6: 173-216.
- John V. 1996b: UTM-grid mapping and distribution patterns of lichens in Turkey. In: *Plant Life in Southwest and Central Asia*, vol. 1: 440-453. Ege University Press, İzmir.
- Özdemirtürk, A. 2003: Two new records for the lichen flora of Turkey. *Turkish Journal of Botany* 27: 69-70.
- Öztürk Ş. 1990: Türkiye İçin Yeni Liken Kayıtları. *Doğa Turk Journal of Botany* 14: 87-96.
- Öztürk Ş, Kaynak G. 1999: New records for the lichen flora of Turkey. *Doğa, Turkish Journal of Botany* 23: 357-358.
- Poelt J. 1974: Bestimmungsschlüssel europäischer Flechten. J. Cramer, Lehre.
- Poelt J, Vězda A. 1981: Bestimmungsschlüssel europäischer Flechten. *Ergänzungs heft II. Bibliotheca Lichenologica* 16:1-390.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM., ed. 1992: The lichen flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.
- Wirth V. 1995: Die Flechten Baden Württenbergs. Teil 1-2. Ulmer, Stuttgart.
- Yazıcı K. 1995: New lichen species for Turkey. *Turkish Journal of Botany* 19: 149-152 (in Turkish).
- Yazıcı K. 1999a: Lichen species in the north of Karacabey County, Bursa Province, Turkey. *Turkish Journal of Botany* 23: 271-276.
- Yazıcı K. 1999b: Lichen flora of Trabzon. *Turkish Journal of Botany* 23: 97-112.
- Yazıcı K, Aslan A. 2002a: New records for the lichen flora of Turkey. *Turkish Journal of Botany* 26: 117-118.
- Yazıcı K, Aslan A. 2002b: Additional lichen records from Rize Province. *Turkish Journal of Botany* 26: 181-193.
- Yazıcı K, Aslan A. 2003: Lichens from the Regions of Gümüşhane, Erzincan and Bayburt (Turkey). *Cryptogamie, Mycologie* 24: 287-300.
- Yazıcı K, Aslan A, Aptroot A. 2004: Four new lichen species from Turkey. *Mycotaxon* 90: 177-180.

A new polypore on *Ginkgo* from China

YU-CHENG DAI

yuchengd@yahoo.com

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

ZHENG WANG

*Department of Biology, Clark University
950 Main Street, Worcester, MA 01610, USA*

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

Abstract — *Oxyporus ginkgonis* sp. nov. is described from *Ginkgo biloba* in northern China. The new species is annual to biennial and has white to cream-white pore surface. It differs from the other species of *Oxyporus* in lacking cystidia. Morphologically comparative studies between *O. ginkgonis* and several *Physisporinus* species are also provided.

Key words — Basidiomycota, morphology, *Polyporaceae*, taxonomy

Introduction

Ginkgos (*Ginkgoaceae*) have a very long history dating back to about 250 million years in the early Permian. At the peak of Ginkgos global distribution, fossil evidences suggest that there were at least 16 genera and Ginkgos had been widespread in Asia, Europe and America (Willis & McElwain 2002). The Ginkgos had been extinct from America and Europe separately about 7 million years and 3 million years ago because of glaciation. The last survivor Ginkgos have taken refuge in the southwestern China, and today the family is represented by a single species, *Ginkgo biloba* L. (Zheng 1983, Shen et al. 2004). Existence of virgin Ginkgos forests in China is controversial and their refuges during glaciation are not clearly known. However, *Ginkgo biloba* trees have been planted by the Buddhist monks for thousands of years, and big trees are commonly found near the pagodas, gardens and temples.

Although *Ginkgo biloba* is known as a living fossil, few fungi have been recorded from this plant. During an investigation of the wood-inhabiting fungi in China, special attention was paid to fungi associated with *Ginkgo* trees, and a white, resupinate polypore was found on the decayed part of the living trees. Morphological characters suggest these collections belong to *Oxyporus* Donk, and represent an undescribed species.

The microscopic routine used in the study is as presented by Dai (1998). The following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width), n = means number of spores measured from given number of specimens. In presenting the variation in the size of spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses; IKI stands for Melzer's reagent and KOH for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and CB- acyanophilous; IKI- means both inamyloid and indextrinoid.

Description

Oxyporus ginkgonis Y.C. Dai, sp. nov.

(Fig. 1)

Carpophorum annuum vel bienne, resupinatum, contextum cremeum. Facies pororum crema; pori 4–5 per mm. Systema hypharum monomiticum, hyphae septatae sine fibulis, hyphae subiculi 3.1–5.2 μ m in diameter. Sporae hyalinae, perlate ellipsoideae vel subglobosae, 5–6.1 $\times$ 4.1–5 μ m.

Holotype here designated. — **China.** Beijing, Xiangshan, Beijing Botanical Garden, on a rotten area of a living *Ginkgo biloba*, 25. VII. 2004 Dai 5336 (holotype in IFP, isotype in H and HMAS).

Etymology. — *Ginkgonis* (Lat.) referring to the tree genus *Ginkgo*.

Fruitbody. — Basidiocarps annual to biennial, resupinate, up to 7 cm long, 4 cm wide, and 5 mm thick at center. Pore surface white to cream, soft, more or less watery, without odor or taste when fresh, when dry pore surface cream to yellowish cream, soft corky; margin very narrow to almost lacking, with the pores usually extending up to the very edge; pores angular, 4–5 per mm, dissepiments thin, slightly lacerate. Section: subiculum cream and soft corky when dry, very thin, 0.1–0.2 mm thick; tube layer cream, fragile to soft corky, tubes up to 4.5 mm long.

Hyphal structure. — Hyphal system monomitic, hyphae simple septate, IKI-, CB+, color unchanged in KOH.

Subiculum. — Subicular hyphae hyaline, thin- to slightly thick-walled, frequently branched, sometimes covered by rod-shaped crystals, interwoven, 3.1–5.2 μ m in diameter.

Tubes. — Tramal hyphae hyaline, thin-walled, occasionally branched, straight, loosely subparallel along tubes, 2.5–3.5 μ m in diameter. Cystidia and cystidioles not seen. Basidia broadly clavate to barrel-shaped, with four sterigmata and a basal simple septum, 16–21 $\times$ 5–7.2 μ m, basidioles mostly barrel-shaped, slightly smaller than basidia.

Spores. — Basidiospores broadly ellipsoid to subglobose, hyaline, thin-walled, smooth, usually bearing a guttule, IKI-, CB-, (4.8–)5–6(–6.5) $\times$ (3.9–)4.1–5(–5.2) μ m, L = 5.4 μ m, W = 4.5 μ m, Q = 1.2–1.22 (n=60/2).

Additional specimen (paratype) examined. — **China.** Beijing, Xiangshan, Beijing Botanical Garden, on rotten part of a living tree of *Ginkgo biloba*, 20.VII.2003 Dai 4619a (IFP, HMAS, H).

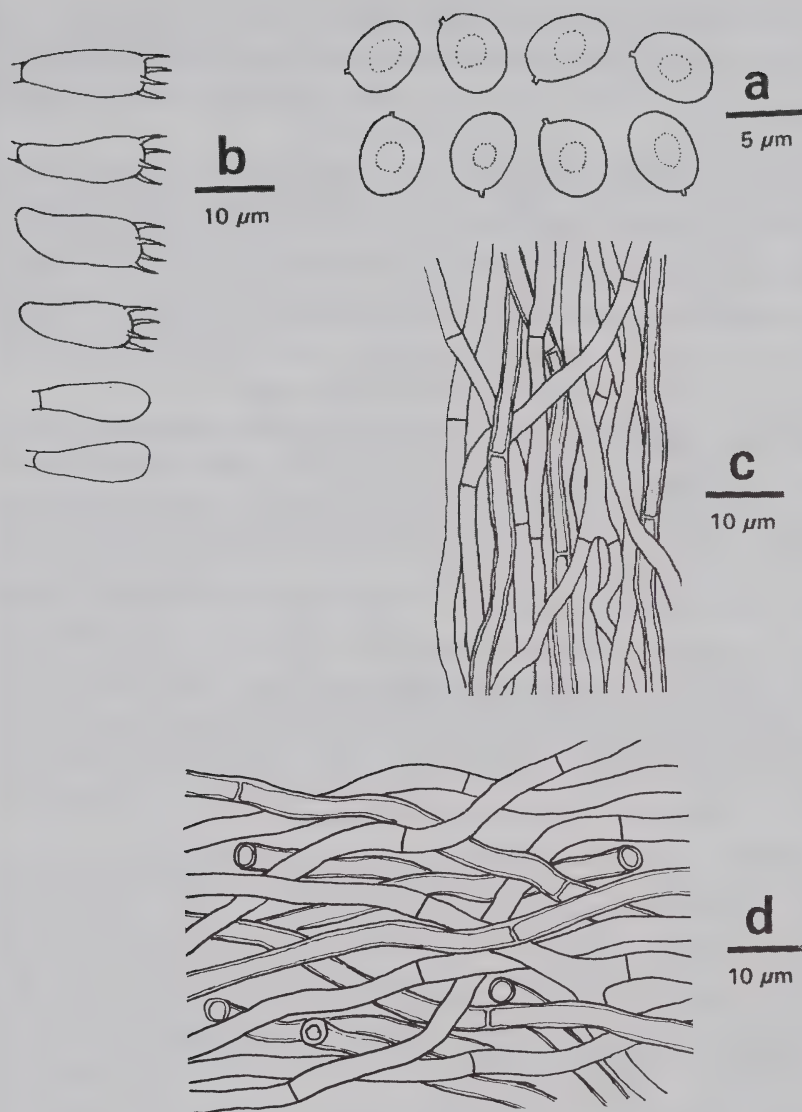


Fig. 1. Microscopic structures of *Oxyporus ginkgonis* —a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from trama. —d: Hyphae from context.

Discussion

Oxyporus ginkgonis is characterised by annual to biennial habit, a white to cream pore surface, subglobose basidiospores, absence of cystidia, and by growth on rotten part of living tree of *Ginkgo biloba*. Two fruit bodies were found on two trees in Beijing Botanical Garden.

The species of *Ceriporia* Donk are similar to *Oxyporus ginkgonis* at many aspects, and do not produce cystidia either. However, basidiospores of *Ceriporia* species are cylindrical to ellipsoid. In addition, the basidiocarps of *Ceriporia* species generally have thick-walled, branched subicular hyphae, the branches arising at right angle or in whorl, and are usually constricted at the septa (Lowe 1966, Gilbertson & Ryvarden 1986, Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001). In contrast, the basidiocarps of *O. ginkgonis* produce subglobose basidiospores, and its subicular hyphae are slightly thicker than the tramal hyphae and not constricted at the septa.

Species in *Physisporinus* P. Karst. also produce resupinate basidiocarps with a monomitic hyphal system, made of simple septate hyphae, subglobose basidiospores, and no cystidia in hymenium. Therefore *Oxyporus ginkgonis* is very close to this genus. In fact, it is difficult to define the generic limits among *Oxyporus*, *Rigidoporus* Murrill and *Physisporinus*. At present we keep the division of the three genera based mainly on morphological features. *Oxyporus* is characterized by species having white or cream-coloured tubes, which are corky and do not change notably when drying. *Rigidoporus* has red- or brown-tinted tubes which harden upon drying and are somehow waxy on their cut surfaces. *Physisporinus* comprises ephemeral, thin basidiocarps, whose tubes are fragile or juicy when fresh. In many species of *Rigidoporus* and *Physisporinus* the bruised parts of fresh specimens change red or finally even black; that change is not seen in *Oxyporus*. For above reason, we keep *Oxyporus ginkgonis* in *Oxyporus*, and it differs from other species in the genus by lack of cystidia.

Physisporinus xylostromatoides (Berk.) Y.C. Dai, *P. sanguinolentus* (Alb. & Schwein.: Fr.) Pilát and *P. vitreus* (Pers.: Fr.) P. Karst. are similar to *Oxyporus ginkgonis*, in what regards the basidiospores and hyphal system. *Physisporinus xylostromatoides* has smaller basidiospores ($4\text{--}5 \times 3\text{--}4.5 \mu\text{m}$), while *P. sanguinolentus* and *P. vitreus* both have a discolouring pore surface upon drying (dark gray or brownish), smaller pores (6–8 per mm), agglutinated hyphae, and fusoid cystidioles. *Oxyporus ginkgonis* has larger pores (4–5 per mm); its hyphae are not agglutinated, and no cystidioles present in its hymenium. In addition, the color of the pore surface of the species remains unchanged upon drying.

Other specimens examined. — *Physisporinus sanguinolentus*. **China**, Jilin Prov., Antu County, Changbaishan Nat. Res., on fallen trunk of *Larix*, 16.VIII.1997 Dai 2544 & 2560 (IFP, H). **Finland**, Uusimaa, Vantaa, Mustavuori, on fallen twig of *Picea*, 4.X.1997 Dai 2719 & Niemelä (H).

— *Physisporinus vitreus*. **China**, Jilin Prov., Dunhua County, Huangnihe, on rotten wood of *Tilia*, 8.VIII.1997 Dai 2299 (IFP). **Finland**, Perä-Pohjanmaa, Rovaniemi, Pisavaara National Park, on rotten wood of *Pinus*, 16.IX.1997 Dai 2668 & Niemelä (H).

— *P. xylostromatoides*. **China**, Beijing, Chinese Academy of Forestry, on *Thuja*, 25.IX.1993 *Dai* 1326, 1327 & 1330 (IFP); Yiheyuan, on *Thuja*, 29.IX.1993 *Dai* 1413 (IFP). **U.S.A.**, Florida, Delray, on hardwood, 11.IX.1950 *Lowe* 4700 (H).

Acknowledgements

We express gratitude to Prof. Teuvo Ahti (University of Helsinki, Finland) for helping with the preparation of the Latin descriptions, and to Drs. Tsutomu Hattori (TFM, Japan) and Cony Decock (MUCB, Belgium) for reviewing the manuscript. YCD thanks Dr. Tuomo Niemelä (University of Helsinki, Finland) for his friendly support studies in various ways at Botanical Museum of University of Helsinki. The project is supported by National Natural Science Foundation of China (Project No. 30425042) and the Talent Programme of the Chinese Academy of Sciences.

Literature cited

- Dai YC. 1998: Changbai wood-rotting fungi 9. Three new species and other species in *Rigidoporus*, *Skeletocutis* and *Wolfiporia* (Basidiomycota, Aphyllophorales). *Ann. Bot. Fennici* 35:143–154.
- Gilbertson RL, Ryvarden L. 1986: North American polypores 1. *Fungiflora*, Oslo. 452 pp.
- Lowe JL. 1966: *Polyporaceae* of North America. The genus *Poria*. State Univ. Coll. For. Syracuse Univ. Techn. Publ. 90: 1–183.
- Núñez M, Ryvarden L. 2001: East Asian polypores 2. *Polyporaceae* s. lato. *Synopsis Fungorum* 14: 170–522.
- Ryvarden L, Gilbertson RL. 1993: European polypores 1. *Synopsis Fungorum* 6: 1–387.
- Shen L, Chen XY, Zhang X, Li YY, Fu CX, Qiu YX. 2004: Genetic variation of *Ginkgo biloba* L. (*Ginkgoaceae*) based on cpDNA PCR-RFLPs: inference of glacial refugia. *Heredity* 10: 1–6.
- Willis KJ, McElwain J. C. 2002: The evolution of plants. Oxford University Press, New York.
- Zheng WJ. 1983: Flora of woody plants in China. Chinese Forest Press, Beijing, 929 pp. (in Chinese).

***Phaeomoniella chlamydospora* and *Phaeoacremonium* species distinguished through cultural characters and ribosomal DNA sequence analysis**

ELIZABETH WHITING¹, MARCOS G. CUNHA² & W. DOUGLAS GUBLER³

¹*ecwhitin@valdosta.edu*

Department of Biology, Valdosta State University
Valdosta, Georgia, USA

²*mgc@agro.ufg.br*

Escola de Agronomia e Engenharia de Alimentos, Univ. Federal de Goiás,
C.P. 131 74001-970, Goiânia, GO, Brasil

³*wdgubler@ucdavis.edu*

Department of Plant Pathology, University of California
Davis, California, USA

Abstract—Representative isolates of *Phaeomoniella chlamydospora* and *Phaeoacremonium* spp. associated with Petri grapevine decline were analyzed using partial sequences of the ITS region of nuclear ribosomal DNA (nrDNA), growth at 35°C, and ability to oxidize gallic and tannic acids. Cultural, physiological, and molecular analyses support separation of *Phaeomoniella chlamydospora* from *Phaeoacremonium* spp. and support separation of *Phaeoacremonium inflatipes* from other *Phaeoacremonium* spp. Two closely related species, *P. aleophilum* and *P. angustius*, clustered in a single clade based on DNA sequence data but formed two groups based on cultural and physiological tests. A dichotomous key is presented that can be used to distinguish between *Phaeomoniella chlamydospora* and *Phaeoacremonium* spp.

Key words—hyphomycetes, DNA analysis, organic acids

Introduction

Species of *Phaeoacremonium* and *Phaeomoniella chlamydospora* have been associated with decline of young grapevines in many of the major wine grape growing regions of the world. *Phaeomoniella chlamydospora* has been isolated from declining grapevines in Portugal (Chicau et al. 2000), Italy (Mugnai et al. 1999), Sicily (Italy) (Sidoti et al. 2000), Australia (Pascoe 1999), California (Scheck et al. 1998a), and South Africa (Ferreira et al. 1994).

Phaeoacremonium angustius W. Gams, Crous & M.J. Wingf. was isolated from a diseased vine in Portugal (Chicau et al. 2000); *Phaeoacremonium aleophilum* W. Gams, Crous, M.J. Wingf. & L. Mugnai was isolated from vines in Australia (Pascoe and Cottrall 2000) and California (Scheck et al. 1998b); *P. inflatipes* W. Gams, Crous & M.J. Wingf. was isolated from vines in California (Scheck et al. 1998b). Symptoms

of infected vines reported by Scheck et al. (1998a, b) include reduced growth, dark-brown to black streaking of vascular tissues, and poor callus formation at the graft union between scion and rootstock. Infected vines also had smaller diameter trunks, shortened internodes and reduced leaf area. Bertelli et al. (1998) described the vascular streaks as occurring in older vessels and tyloses and dark gummy masses were observed to fill the lumen of older xylem vessels in the innermost ring.

Isolates from symptomatic tissue were originally identified as *Phaeoacremonium* spp. based on cultural characteristics, colony growth rate and color, and conidium morphology. As more isolates from grapevines were examined, Crous et al. (1996) observed that the species isolated most often, *P. chlamydosporum*, was morphologically different from other species of *Phaeoacremonium* in color of conidiophores, color and shape of conidia, colony growth in culture, and in producing a *Phoma*-like anamorph. Based on these morphological differences Crous and Gams (2000) placed *P. chlamydosporum* in a new genus creating the new combination *Phaeomoniella chlamydospora* (W. Gams, Crous, M.J. Wingf. & L. Mugnai) Crous & W. Gams.

Phaeomoniella chlamydospora is relatively easy to identify in culture. However, *P. aleophilum*, *P. angustius*, and *P. inflatipes*, also isolated from grapevines, can be difficult to identify and separate based on morphological and cultural characters alone. Distinguishing species of *Phaeoacremonium* is particularly important as Dupont et al. (2000b) questioned the exact role of *P. inflatipes* in both decline of young vines (Petri vine decline) and decline of older vines (esca).

Molecular biology methods have been used to examine genetic variation in *P. aleophilum* and *Pm chlamydospora* and to detect fungi in grapevine tissue (Tegli et al. 2000a; Tegli et al. 2000b; Groenewald et al. 2000). Based on molecular studies of the genus *Phaeoacremonium* using internal transcribed spacer regions (ITS) of ribosomal DNA (rDNA), Dupont et al. (2000a) synonymized *P. aleophilum* and *P. angustius*. Thus, the ITS region can be used to characterize isolates that are difficult to identify based on morphological characteristics alone and to determine species composition within *Phaeoacremonium*.

The objectives of this study were: 1) to characterize isolates identified as *Pm. chlamydospora* and *Phaeoacremonium* spp. using cultural characters (growth at 35°C and diffusion of yellow pigment into agar), a biochemical test (oxidation of organic acids), and DNA sequence analysis and, 2) to determine whether separation of *P. angustius*, *P. aleophilum*, and *P. inflatipes* into three distinct species is warranted.

Materials and Methods

Fungal isolates

All single-spore isolates as described in Table I were grown on potato dextrose agar amended with 0.1 g/mL Sigma Tetracycline (PDA-Tet) at room temperature (20-22 °C).

Temperature study

Five mm plugs of agar with actively growing mycelia of isolates growing on PDA-Tet were placed on fresh PDA-Tet or 1% MEA (malt extract agar). There were three replicate plates of each isolate x medium x temperature treatment. Plates were incubated at temperatures of 25, 30, and 35°C. Colony diameter was measured every week for four weeks and diameter was recorded as the

Table 1. Geographic origin, host, and isolate designation based on morphology of isolates of *Phaeoacremonium* and *Phaeomoniella chlamydospora*

Morphological identification	Isolate ^a	Accession Number ^b	Geographic origin	Host
<i>P. aleophilum</i>	CBS 246.91	AY772239	Yugoslavia	<i>Vitis vinifera</i>
	CBS 631.94	AY772242	Italy	<i>Vitis vinifera</i>
	51		South Africa	<i>Vitis vinifera</i>
	75		USA, California (Napa County)	<i>Vitis vinifera</i>
	8		USA, California (Riverside County)	<i>Vitis vinifera</i>
	11		USA, California (Riverside County)	<i>Vitis vinifera</i>
<i>P. angustius</i>	CBS 249.95	AY772240	USA, California	<i>Vitis vinifera</i>
	CBS 100397	AY772243	Italy	<i>Vitis vinifera</i>
<i>Pm. chlamydospora</i>	CBS 161.90	AY772236	South Africa	<i>Vitis vinifera</i>
	CBS 229.95	AY772237	Italy	<i>Vitis vinifera</i>
	44		USA, California (Mendocino County)	<i>Vitis vinifera</i>
	62		USA, California (Sonoma County)	<i>Vitis vinifera</i>
	65		USA, California (Napa County)	<i>Vitis vinifera</i>
<i>P. inflatipes</i>	CBS 222.95	AY772238	USA, California	<i>Vitis vinifera</i>
	CBS 391.71	AY772241	USA, Texas	<i>Quercus virginiana</i>
	61		USA, California (Sonoma County)	<i>Vitis vinifera</i>
	97		USA, California (Sonoma County)	<i>Vitis vinifera</i>
	99		USA, California (Sonoma County)	<i>Vitis vinifera</i>
<i>P. parasiticum</i>	CBS 984.73		Tunisia	<i>Prunus armeniaca</i>
<i>P. viticola</i>	CBS 101739	AY772244	France	<i>Vitis vinifera</i>

^aCBS: Centraal Bureau voor Schimmelcultures (Baarn, The Netherlands)^bGenBank Accession Number

average of two diameters taken at right angles to each other. Pigment diffusion into the agar was noted. The experiment was repeated twice.

Oxidation of organic acids

Oxidation of gallic and tannic acid was determined by growing fungi on malt agar amended with gallic acid or tannic and noting the reaction (Davidson et al. 1938). Gallic acid medium (GAM) was prepared using 0.5% Fisher gallic acid, 1.5% Difco malt extract, and 2% agar. Tannic acid medium (TAM) was prepared using 0.5% Fisher tannic acid, 1.5% Difco malt extract, and 2% agar.

Heating the acid with the agar hydrolyzes the agar. Therefore, acids were added to the agar after autoclaving. Twenty grams of agar and 15 g malt extract were dissolved in 850 mL of de-ionized water in 2 L flasks. One-hundred-fifty mL of de-ionized water was placed in two separate flasks. The flasks were autoclaved at 121 C for 20 minutes. After autoclaving, five grams of either gallic acid or tannic acid were dissolved in separate flasks of sterile water. When the flasks containing malt agar were cool to the touch, the gallic acid and tannic acid solutions were added to the flasks and mixed. When tannic acid is added to malt agar, the agar turns milky-white. Adding gallic acid to the agar does not cause a color change. Both media had pH adjusted to 6 with 1M KOH. Approximately forty mL of each media was poured into 9 cm petri plates and cooled.

Plugs of agar, 5 mm dia, with growing mycelium were cut with a n° 2 cork borer from the leading edge of cultures growing on PDA-Tet and placed mycelium-side down on the media. Three plugs of each isolate were placed on each petri plate. There were three replicate plates with three plugs each. Plates were sealed with parafilm and incubated at 22 C in the dark. The experiment was repeated two times.

Oxidation of acids was noted by the appearance of a bronze halo or diffusion zone underneath and out from the agar plug after one or two weeks. A reaction was considered positive if a bronze halo was observed and negative if there was no discoloration or halo around the plug. Clear zones or decolorized areas around the plugs were not considered a positive reaction. Reactions were counted as a percentage of plugs showing positive or negative reactions.

DNA extraction

Fungal DNA was extracted by a modified method of Ceniz (1992). Fungi were grown on cellophane on PDA-Tet for two weeks. Mycelia were scraped off of the cellophane and washed with 500 μ L TE buffer (10 mM Tris, 1 mM EDTA) in 1.5 mL Eppendorf tubes. The tubes were centrifuged at 14 000 rpm for 5 min. The TE was decanted and 300 μ L extraction buffer (200mM Tris, pH 8, 250mM NaCl, 25 mM EDTA, 0.5% SDS) and 5-10 μ L glass beads (Sigma) were added and tubes were vortexed for 1 min. Mycelia were crushed with a plastic grinder and tubes vortexed for 1 min. One hundred fifty μ L of 3 M sodium acetate pH 5.2 was added and tubes were placed at -20°C for 25 min and then in a water bath at 28 C for 1 min. Tubes were centrifuged at 14 000 rpm for 10 min. The supernatant was transferred to new tubes and 400 μ L isopropanol was added. Tubes were held for 10 min at 22°C to precipitate DNA. The DNA was pelleted by centrifugation at 14 000 rpm for 10 min. After centrifugation the pellet was washed with 100 μ L 70% ethanol and centrifuged at 14 000 rpm for 2 min. The supernatant was discarded and the pellet was dried under vacuum overnight. After drying, 100 μ L TE was added to tubes.

Polymerase chain reaction (PCR)

A portion of the nuclear ribosomal gene comprising the end of the ITS1, the 5.8S, ITS2, and a portion of the 26S region was amplified using primers ITS3: 5'ATCGATGAAGAACGCAGC3' (from White et al. 1990) and D2: 5'TCCGTGTTTCAAGACGGG3' (from Dupont et al. 1998). The PCR reaction mixture included 0.4 μ L Taq polymerase (5 U/ μ L; Promega, Madison, Wisconsin) per reaction, 5 μ L of 10 $\times$ buffer supplied with the enzyme, 5 μ L of 25 mM MgCl_2 , 3 μ L 0.01% Blotto milk suspension, 5 μ L of 2.5mM dNTPs, 3 μ L of 50 μ M ITS3 primer and 3 μ L of 50 μ M D2 primer, and 2 μ L of 10 ng/ μ L DNA in a final volume of 50 μ L. As a negative control, 2 μ L of milliQTM water was used instead of fungal DNA. All reactions were overlaid with roughly 50- μ L mineral oil. This amplification was performed on a Gradient 96 Robocycler (Stratagene Cloning Systems, La Jolla, California). Cycling conditions were 94 C for 2 min for initial denaturation, 35 $^{\circ}$ Cycles of 94 C for 1 min, 58 C for 1 min and 72 C for 1.5 min and a final elongation period of 72 $^{\circ}$ C for 5 min. After amplification, PCR products were electrophoresed on 1% agarose gel in 1x TBE buffer at constant power, 60 volts, for $\sim$ 2.5 h, stained in ethidium bromide (0.5 μ g/mL) and

visualized, and documented with a UVP ImageStore 7500 white/UV Transilluminator (UVP Inc., Upland, California).

DNA sequencing

The PCR-amplified rDNA region was cloned using the original TA cloning kit with pCR®2.1 plasmid vector (Invitrogen – Carlsbad, California) following manufacturer's instructions. A fragment of rDNA genes was amplified and inserted into the pCR®2.1 plasmid. Using a heat shock procedure, INVαF' *E. coli* cells were transformed with inserted pCR®2.1 plasmids. Successfully transformed *E. coli* cells, which grew as white colonies on Luria-Bertani (LB) medium containing kanamycin and x-gal, were transferred to liquid LB medium and grown overnight. Plasmid extraction was carried out with QIAprep miniprep kit (QIAGEN, Inc. Valencia, California). Purified plasmid concentration was determined with a DyNA Quant™ 200 fluorometer (Hoefer Scientific Instruments, San Francisco, California), and then adjusted to 150–200 ng/μL with EB buffer. All plasmid extractions were maintained at –20 °C.

Both DNA strands of either two or three rDNA clones from each isolate of *Phaeoacremonium* and *Phaeomoniella chlamydospora* studied were sequenced with an ABI PRISM 377 DNA Sequencer using a Big Dye Terminator Chemistry (Perkin-Elmer/ABI, Forest City, California) at the University of California DNA sequencing facility (5350 Storer Hall, Davis, California 95616). M13F (-20) and M13R primers (Invitrogen – Carlsbad, California) were used for sequencing.

Five to seven sequences were generated from each isolate of *Phaeoacremonium* or *Phaeomoniella chlamydospora*. All sequences including at least two forward and two reverse sequences of the same *Phaeoacremonium* and *Phaeomoniella chlamydospora* isolates were aligned with the Multalin software, version 5.4. Aligned sequences were edited using a word processor (Microsoft Word 97) and adjustments were manually performed on the consensus sequences for resolving the exact rDNA fragment (932 to 949 bps) delimited by primers D2 and ITS3. All sequences were deposited in GenBank (Table 1). Neighbor joining cluster analyses were performed using PAUP 4.0b10 Beta version. A sequence of *Magnaporthe grisea* (GenBank AB026819) was used as the outgroup. Support for each clade was estimated by using 1,000 replicates in bootstrap analysis.

Results

Temperature study

Isolates varied in their growth at 35°C (Table 2). None of the isolates of *Pm. chlamydospora* grew at 35°C. Isolates identified as *P. aleophilum* (CBS 631.94, CBS 246.91, 61, and 99) grew at 35°C with colony diameters ranging from 10–34 mm after 4 wk. Isolates identified as *P. angustius* (CBS 100397 and CBS 249.95) grew at 35°C with a colony diameter ranging from 12–16 mm after 4 wk. Isolates identified as *P. inflatipes* (CBS 222.95 and 97) grew at 35°C with a colony diameter of 11–13 mm after 4 wk. One isolate identified as *P. inflatipes* (CBS 391.71) grew very little at 35°C and the single isolate of *P. viticola* did not grow at all at 35°C. Three isolates produced a yellow pigment in the agar: CBS 222.95 identified as *P. inflatipes*, CBS 249.95 identified as *P. angustius*, and 97 identified as *P. inflatipes* (Table 2).

Oxidation of organic acids

Positive reactions indicating the fungi could oxidize gallic and tannic acids were indicated by a brown color diffusing out from the agar plug into the medium and by the formation of a corona around the plug. None of the isolates of *Pm. chlamydospora* (CBS 161.90, CBS 229.95, 44, 62, 65) and none of the isolates identified as *P. aleophilum* (CBS

Table 2. Grouping of isolates based on growth at 35°C after four weeks, diffusion of pigment into PDA-Tet medium, and oxidation of gallic acid and tannic acid.

Poly-phase ID ^a	Morphological ID ^b	Isolate #	Colony diam 35°C (mm)	Pigment diffusion	Gallic acid oxidation ^c	Tannic acid oxidation	ITS group ^d
<i>Pmc</i>	<i>Pm. chlamydospora</i>	CBS 161.90	—	—	—	—	<i>Pmc</i>
	<i>Pm. chlamydospora</i>	CBS 229.95	—	—	—	—	<i>Pmc</i>
	<i>Pm. chlamydospora</i>	44	—	—	—	—	—
	<i>Pm. chlamydospora</i>	62	—	—	—	—	—
	<i>Pm. chlamydospora</i>	65	—	—	—	—	—
<i>Pa</i>	<i>P. aleophilum</i>	CBS 631.94	25-34	—	—	—	<i>Pa</i>
	<i>P. aleophilum</i>	CBS 246.91	10-12	—	—	—	<i>Pa</i>
	<i>P. aleophilum</i>	61	25-30	—	—	—	—
	<i>P. aleophilum</i>	99	20-21	—	—	—	—
	(<i>P. angustius</i>)	CBS 100397	15-16	—	—	+	<i>Pa</i>
	(<i>P. inflatipes</i>)	CBS 222.95	11-13	+	+	+	<i>Pa</i>
	<i>P. angustius</i>	CBS 249.95	12-13	+	+	+	<i>Pa</i>
	(<i>P. inflatipes</i>)	97	12-13	+	+	+	—
<i>Pp</i>	<i>P. parasiticum</i>	CBS 984.73	18-19	—	+	+	—
<i>Pi</i>	<i>P. inflatipes</i>	CBS 391.71	5-7	—	+	+	<i>Pi</i>
<i>Pv</i>	<i>P. viticola</i>	CBS 101739	—	—	+	+	<i>Pv</i>

^aPolyphase ID refers to identification based on morphotype, physiotype, or genotype.^bIdentification (ID) of culture based on morphology or as received.^cA positive reaction (+) indicating oxidation of the acids is evident by a brown corona in the medium around the plug. No brown color diffusing into the medium would indicate a negative reaction (-). The range of plugs showing a positive reaction was 21-27 out of a total of 27 plugs.^dGroup designation from Fig. 1. Dash indicates data not available.

631.94, CBS 246.91, 61 and 99) oxidized gallic acid or tannic acid (Table 2). Isolates identified as *P. parasiticum* (CBS 984.73), *P. inflatipes* (CBS 222.95, CBS 391.71, and 97) and an isolate identified as *P. angustius* (CBS 249.95) and the single isolate of *P. viticola* (CBS 101739) were able to oxidize both gallic acid and tannic acid.

DNA sequence analyses

The ITS sequence alignment obtained was 966 bp long. ITS sequence data analyses showed that *Pm. chlamydospora* isolates (CBS 161.90 and CBS 229.95) were distinctly separate from the other groups with 100% bootstrap support (Fig. 1). The analyses also supported *P. inflatipes* (CBS 391.71) and *P. viticola* (CBS 101739) as distinct with 100% and 99% bootstrap support, respectively (Fig. 1). The remaining *Phaeoacremonium* isolates grouped into a single clade (87%). There were very few nucleotide differences among those isolates clustered in this clade. There were usually fewer than five nucleotides between any pair of sequenced fragments. This suggested that they must be very closely related and probably represent a single species.

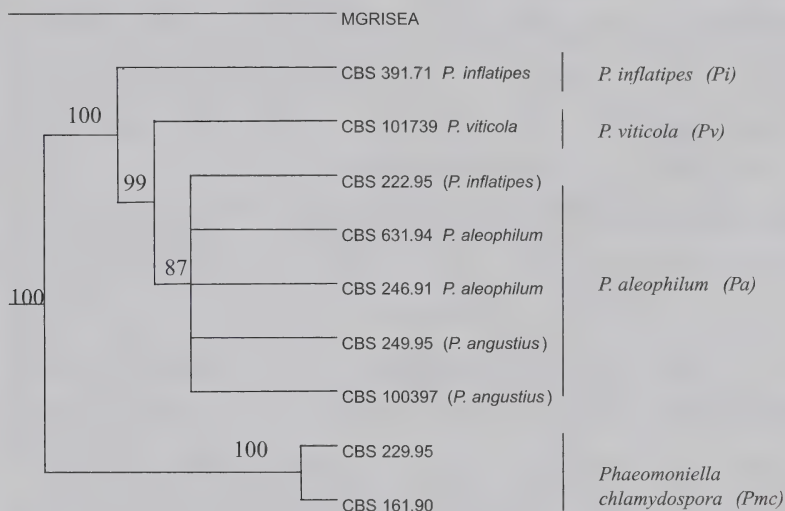


Fig. 1. Neighbor-joining bootstrap cladogram obtained from analysis of nuclear ribosomal DNA (nrDNA) sequences (5.8S, ITS2 plus a portion of 26S region) using PAUP (tree length 285, CI=0.940, RI=0.930, RC=0.875, HI=0.0596). Bootstrap values above 80% are denoted for the node to the right of the number. *Magnaporthe grisea* (GenBank AB026819) was used as the outgroup.

Discussion

Our results support the separation of *Pm. chlamydospora* from *Phaeoacremonium* based on cultural characteristics, a physiological test, and ITS sequence data. All isolates of *Pm. chlamydospora* tested were consistent in their reaction to cultural and physiological tests. They also clustered together based on the analyses of DNA sequence data with 100% bootstrap support. Dupont et al. (1998) first proposed the separation of *Pm. chlamydospora* from *Phaeoacremonium* based on ITS sequences and this separation was subsequently confirmed by Tegli et al (2000). Our results from sequence analysis of the rDNA ITS region are consistent with both Dupont and Tegli and, together with

cultural and physiological data, demonstrate further support for *Pm. chlamydospora* as separate species.

Cultural, physiological, and molecular data support the separation of the isolate of *P. inflatipes* tested (CBS 391.71) as a distinct group. Although Crous et al. (1996) earlier re-interpreted *P. inflatipes* as *P. parasiticum* using molecular methods, Dupont et al. (2000) have confirmed this isolate (CBS 391.71) as *P. inflatipes* using restriction pattern analysis. Dupont et al. (2000) report that *P. inflatipes* is closely related to *P. parasiticum* and is intermediate between *P. parasiticum* and *P. rubrigenum*. In our study the main cultural distinction between *P. inflatipes* and *P. parasiticum* is the ability of *P. parasiticum* to grow at 35°C; pigment diffusion into agar and oxidization of organic acids did not distinguish these species.

Separation of *P. viticola* (CBS 101739) from other *Phaeoacremonium* species is supported by molecular and cultural characteristics. Based on culture characteristics, *P. viticola* is closest to *P. inflatipes*, but a distinguishing feature of *P. viticola* is the production of a bluish-red pigment in agar that can be seen in colony reverse. Results from our study are consistent with that of Dupont et al. (2000) and offer further support for the separation of *P. viticola* from other species of *Phaeoacremonium*.

Five isolates comprising three morphological species clustered into a single clade based on ITS sequence data (87% bootstrap support). In this clade there are less than five nucleotide differences within the ITS rDNA region between any pair of isolates. However, even though ITS sequence data is similar, there is some variability in terms of cultural and physiological responses. Isolates in this clade formed two groups based on pigment diffusion and oxidization of organic acids. One group was composed of isolates identified morphologically as *P. aleophilum* (CBS 631.94, CBS246.91) along with two additional isolates of *P. aleophilum* (61 and 99). Within this group, isolates had similar cultural and physiological responses: growth at 35°C, diffusion of a pigment into the agar, and no oxidization of organic acids. One isolate received as *P. angustius* (CBS100397) was similar to the *P. aleophilum* group based on cultural and physiological tests and was probably misclassified. Two other isolates in this clade, CBS 222.95 (received as *P. inflatipes*) and CBS 249.95 (received as *P. angustius*), were probably misidentified. In our studies the two isolates were culturally similar and oxidized both organic acids. In this case, it is not surprising that the two isolates were similar. Tegli et al. (2000) found that both isolates had identical sequences based on ITS sequence data and therefore reported them as conspecific. Because of this conspecificity, they suggest that CBS 249.95 (*P. angustius*) and CBS 222.95 (*P. inflatipes*) be transferred to *P. aleophilum* as was proposed earlier by Dupont et al. (1998). Isolate 97, identified morphologically as *P. inflatipes*, was placed in this group based on cultural and physiological results.

Comparisons of sequence data show that the five *Phaeoacremonium* isolates, representing morphological species *P. aleophilum* and *P. angustius*, cluster into a single clade and probably represent a single species. Dupont et al. (1998) proposed to group the two species together and to designate this group as *P. aleophilum*. Our results from ITS sequence analysis support this designation but cultural and physiological data indicate some variability within this species concept.

A dichotomous key is presented that can be used to distinguish closely related species of *Phaeoacremonium* and to separate species of *Phaeoacremonium* from *Phaeomoniella chlamydosporum*.

1a Growth at 35°C	2
2a Oxidation of organic acids	3
2b No oxidation of organic acids	<i>P. aleophilum</i>
3a Diffusion of yellow pigment into agar	<i>P. angustius</i>
3b No pigment diffusion into agar	<i>P. parasiticum</i>
1b No Growth at 35°C	4
4a Oxidation of organic acids	5
4b No oxidation of organic acids	<i>Phaeomoniella chlamydosporum</i>
5a Colony reverse blue-red	<i>P. viticola</i>
5b Colony reverse not blue-red	<i>P. inflatipes</i>

Acknowledgements

We are grateful to Dr. J. Chen (USDA-ARS, Parlier, California) and Dr. F. Fernandez (EM Lab, Boston, Massachusetts) for their critical review of this manuscript.

Literature Cited

- Bertelli E, Mugnai L, Surico G. 1998. Presence of *Phaeoacremonium chlamydosporum* in apparently healthy rooted grapevine cuttings. *Phytopathol Mediterr* 37: 79-82.
- Cenis JL. 1992. Rapid extraction of fungal DNA for PCR amplification. *Nucleic Acids Research*. 20: (9) 2380.
- Chicau G, Abiom-Inglez M, Cabral S, Cabral, JPS. 2000. *Phaeoacremonium chlamydosporum* and *Phaeoacremonium angustius* associated with esca and grapevine decline in Vinho Verde grapevines in northwest Portugal. *Phytopathol. Mediterr.* 39: 80-86.
- Corpet, F. 1988. Multiple sequence alignment with hierarchical clustering. *Nucleic Acids Research* 16 (22), 10881-10890.
- Crous PW, Gams W. 2000. *Phaeomoniella chlamydospora* gen. et comb. nov., a causal organism of Petri grapevine decline and esca. *Phytopathol Mediterr* 39: 112-118.
- Crous PW, Gams W, Wingfield MJ, van Wyk PS. 1996. *Phaeoacremonium* gen. nov. associated with wilt and decline diseases of woody hosts and human infections. *Mycologia* 88: 86-796.
- Davidson RW, Campbell WA, Blaisdell DJ. 1938. Differentiation of wood-decaying fungi by their reactions on gallic or tannic acid medium. *J Agric Res* 57: 683-695.
- Dupont J, Laloui W, Roquebert MF. 1998. Partial ribosomal DNA sequences show an important divergence between *Phaeoacremonium* species isolated from *Vitis vinifera*. *Mycol Res* 102 (5): 631-637.
- Dupont J, Laloui W, Larignon P, Roquebert MF. 2000a. *Phaeoacremonium viticola*, a new species associated with Esca disease of grapevine in France. *Mycologia* 92: 499-504.
- Dupont J, Magnin, S, Paronnaud J, Roquebert MF. 2000b. The genus *Phaeoacremonium* from a molecular point of view. *Phytopathol Mediterr* 39: 119-124.
- Ferreira JHS, van Wyk PS, Vente, E. 1994. Slow dieback of grapevine: Association of *Phialophora parasitica* with slow dieback of grapevines. *S Afr J Enol Vitic* 15: 9-11.

- Groenewald M, Bellstedt DU, Crous PW. 2000. A PCR-based method for the detection of *Phaeoconiella chlamydospora* in grapevines. S Afr J Sci 96: 43-46.
- Mugnai L, Graniti A, Surico G. 1999. Esca (black measles) and brown wood-streaking: Two old and elusive diseases of grapevines. Plant Dis 83: 404-418.
- Pascoe I. 1999. Grapevine trunk diseases-black goo decline, esca, *Eutypa* dieback and others. Aust Grape Grower Winemaker 429: 24-28.
- Pascoe I, Cottrell E. 2000. Developments in grapevine trunk diseases research in Australia. Phytopathol. Mediterr. 39: 68-75.
- Scheck H, Vasquez S, Fogle D, Gubler WD. 1998a. Grape growers report losses to blackfoot and grapevine decline. California Agriculture 52: 19-23.
- Scheck H, Vasquez S, Fogle D, Gubler WD. 1998b. Three *Phaeoacremonium* spp. cause young grapevine decline in California. Plant Dis 82: 590.
- Sidoti A, Buonocore E, Serges T, Mugnai L. 2000. Decline of young grapevines associated with *Phaeoacremonium chlamydosporum* in Sicily (Italy). Phytopathol Mediterr 39: 87-91.
- Tegli S, Santilli E, Bertelli E, Surico G. 2000a. Genetic variation within *Phaeoacremonium aleophilum* and *Phaeoacremonium chlamydosporum* in Italy. Phytopathol Mediterr 39: 125-133.
- Tegli S, Bertelli E, Surico G. 2000b. Sequence analysis of ITS ribosomal DNA in five *Phaeoacremonium* species and development of a PCR-based assay for the detection of *P. chlamydosporum* and *P. aleophilum* in grapevine tissue. Phytopathol Mediterr 39: 134-149.
- White TJ, Bruns R, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis M, Gelfand DH, Sninsky JJ, White TJ, eds. PCR Protocols: a Guide to Methods and Applications San Diego, California: Academic Press. 315-322.

Taxonomy and nomenclature of *Gymnopilus bellulus* and *G. microsporus* (Agaricales, Cortinariaceae)

JAN HOLEC

jan.holec@nm.cz

*National Museum, Mycological Department, Václavské nám. 68
115 79 Praha 1, Czech Republic*

Abstract—Original descriptions, types and other material of *Gymnopilus bellulus* described from North America and *Gymnopilus microsporus* from Europe were studied to determine whether the European *G. bellulus* differs sufficiently from the American concept to be named *G. microsporus*. It was found that the *G. bellulus* type matches the original description and recent material from both continents and that American and European collections of *G. bellulus* are conspecific. Singer based *Gymnopilus microsporus* on a collection from the Caucasus validated by Bresadola's Latin description of *Flammula liquiritiae*. *F. liquiritiae* sensu Bresadola is difficult to interpret due to discrepancies in its description. The only available herbarium specimens represent *Pholiota mixta*, whereas the Singer's material of *G. microsporus* is identical with *Gymnopilus bellulus*. This paper selects a lectotype for *Gymnopilus bellulus* and epitype for *G. microsporus* to support the fact that *G. microsporus* sensu Singer is a synonym of *G. bellulus*.

Key words—fungi, type study

Introduction

Gymnopilus bellulus (Peck) Murrill is a well known fungus included in most mycological floras and monographs of *Gymnopilus* in Europe and North America (e.g. Kühner & Romagnesi 1953, Hesler 1969, Moser 1983, Singer 1986, Høiland 1990, Orton 1993, Breitenbach & Kränzlin 2000, Keller & Moser 2001, Ludwig 2000, 2001, Bon & Roux 2002). However, some problems concerning its original versus recent concepts and interpretation of type specimen are mentioned by Hesler (1969: 38) and Singer (in Moreno & Esteve-Raventós 1990: 288). They indicate that the recent concept (species with spores measuring about $4.5\text{--}6.5 \times 3\text{--}4 \mu\text{m}$) is not in accordance with the type specimen, which is reputedly a fungus with much larger spores ($8\text{--}9.5 \times 5\text{--}5.5 \mu\text{m}$, see Hesler 1969: 38).

Gymnopilus microsporus (Singer) ex Singer is a similar but less well-known fungus omitted in most recent taxonomical works on *Gymnopilus*. It is only included in the key by Moser (1983) and discussed by Moreno & Esteve-Raventós (1990). Works only mentioning the name are not included here. Moreno & Esteve-Raventós (1990) consider *G. microsporus* a correct name for *Gymnopilus bellulus* sensu European authors (non

Peck), but with a question mark. To clear up these discrepancies, I tried to revise original descriptions, types and material collected by Peck and Singer. The aim was to evaluate the taxonomic concept of both taxa. The study was carried out within the framework of my monographic work on the genus *Gymnopilus* in the Czech Republic and adjacent regions of Central Europe (Holec 2001b, 2002, Holec et al. 2003). Type studies in *Gymnopilus* are recently carried out also by Guzmán-Dávalos (2003).

Material and Methods

Microcharacters were studied on material mounted in a 5 % KOH solution. Pigmentation of hyphae of the pileus and stipe cuticle was studied in pure water and their arrangement was observed on cap surface. Iodine reaction was studied in Melzer's reagent prepared according to the formula given in Moser (1983), cyanophilous reaction in cotton blue (according to Kotlaba & Pouzar 1964, Singer 1986) after short boiling. Examinations were made using an Olympus BH-2 microscope. For spore size measurements, 20 randomly selected mature spores were used per collection. Immature spores (extremely small ones or those having a thin wall and hyaline content) and aberrant spores (1.5–2 times longer than the normal ones) were not measured. Marginal values of spore size are given in brackets and represent at most 10 % of all spores measured in each species. Illustrations of microcharacters were drawn at a magnification of 1250x using the drawing tube.

Acronyms of herbaria are cited according to Holmgren et al. (1990). Abbreviations: E: length/width ratio of the spores. Q: mean value of E for all spores studied.

Results

Gymnopilus bellulus (Peck) Murrill

Bas.: *Agaricus bellulus* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 51, 1873.

≡ *Gymnopilus bellulus* (Peck) Murrill, North American Flora, vol. 10, part 3: 200, 1917. ≡ *Naucoria bellula* (Peck) Sacc., Syll. fung. 5: 841, 1887. ≡ *Flammula bellula* (Peck) Pilát, Klíč k určování našich hub hřibovitých a bedlovitých (*Agaricalium europaeorum clavis dichotomica*): 351, 1951.

Lectotype (designated here): USA, New York, herb. NYS: mycology type database 450; data from old label and original newspaper envelope: *Agaricus bellulus*, Lowville, Lewis Co., Sept., leg. C.H. Peck 68; the specimen is labelled as “type” (on box) or “syntype” (on computer-written label). The collection consists of about 20 well-preserved but slightly overdried mature and young fruitbodies.

Macrocharacters: see the original description (Peck 1873: 51) and later descriptions by Peck (1874: 58), Hesler (1969), etc.

Lectotype study: Spores small, (5.2–)5.6–6.4 x 3.2–3.6 μm , E = 1.56–2.00, Q = 1.72, rusty yellow in KOH, ellipsoid to ellipsoid-amygdaliform, with distinct suprahilar depression in side view, wall rusty, surface moderately to coarsely verrucose, without plate, slightly dextrinoid (with pale reddish-brown tinge in Melzer's reagent), mature spores acyanophilous or only slightly cyanophilous, the immature ones and those with

a broken wall distinctly cyanophilous. Basidia 4-spored, $19\text{--}22 \times 5\text{--}6 \mu\text{m}$, cylindrical to narrowly clavate with a median constriction. Cheilocystidia numerous but poorly preserved, mostly collapsed, $18\text{--}25 \times 3\text{--}6 \mu\text{m}$, cylindrical to narrowly lageniform with obtuse to capitate apex, neck $1.5\text{--}2 \mu\text{m}$, head $3\text{--}4 \mu\text{m}$, thin-walled. Pleurocystidia not observed. Lamellar trama regular, made up of cylindrical hyphae $2\text{--}8(10) \mu\text{m}$ wide, wall yellow-rusty incrustated. Pileus cuticle studied on surface only in order not to damage the material, consisting of cylindrical to slightly inflated cells $4\text{--}13(16) \mu\text{m}$ wide, terminal elements slightly clavate, cells incrustated in a "tiger" pattern, pileocystidia not observed. Stipe cuticle a cutis of densely arranged parallel hyphae $1.5\text{--}3 \mu\text{m}$ broad, with yellow-rusty incrustations, at places with nests of interwoven hyphae, caulocystidia not observed. Clamp connections present.

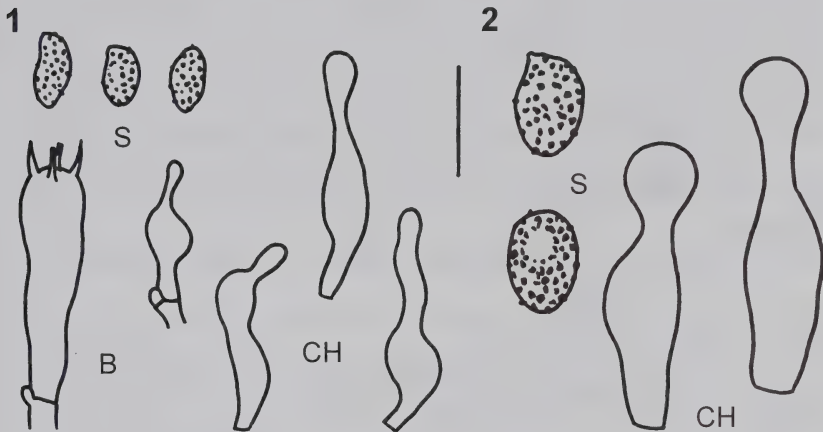


Fig. 1. Collections identified as *Gymnopilus bellulus* by C.H. Peck (as *Agaricus bellulus* or *Naucoria bellulus* on original labels). 1: Lowville, lectotype, NYS. 2: Forestburgh, NYS. For details see collections studied. Note the clear difference in spore size and shape of cheilocystidia. B: basidium, CH: cheilocystidia, S: spores. Scale bar = $10 \mu\text{m}$.

Conclusion: The lectotype agrees not only with the original description of *Gymnopilus bellulus* by Peck but also with material from the USA and Europe commonly identified as *G. bellulus* (see the collections studied). This means that the American and European collections can be considered conspecific, at least according to the classical morphological and anatomical characters.

Discussion: Peck (1873, 1874) characterised his *Agaricus bellulus* as a small fungus with bright watery-cinnamon pileus, yellow lamellae, reddish-brown stipe and spores measuring $5 \times 3.5 \mu\text{m}$. At the subgeneric level, he placed it into *Naucoria*. Some authors (e.g. Moreno & Esteve-Raventós 1990) are convinced that *G. bellulus* in the sense of recent (mostly European) authors is different from the type of *G. bellulus*. Moreno & Esteve-Raventós (1990) suggested to use the name *Gymnopilus microsporus* for European *G. bellulus*. Similarly, Hesler (1969: 38) writes that „Peck's type is confusing“. However, his description (Hesler 1969: 37) well agrees both with the original description by Peck (1873) and recent concept of *G. bellulus*.

Singer (in Moreno & Esteve-Raventós 1990: 288) concluded that the type of *Gymnopilus bellulus* represents a species with large spores, whereas *G. bellulus* of recent authors is a species with small dextrinoid spores. According to him, *G. microsporus* sensu Singer (having non-dextrinoid spores) is not identical with *G. bellulus* of recent authors but could be identical with *G. bellulus* sensu Kühner & Romagnesi (1953). In my opinion, Singer's conclusions based on the reaction of spores with Melzer's reagent are of limited value. In the lectotype of *G. bellulus* and epitype of *G. microsporus* I studied, the reaction is quite identical – the spores of both species are slightly dextrinoid.

To solve all these discrepancies, I tried to obtain the original material of *G. bellulus* including the type on loan and compare it with collections from Europe. I obtained 8 specimens of *Agaricus bellulus* (= *Gymnopilus bellulus*) identified (and mostly also collected) by C.H. Peck from NYS herbarium. There were no collections of *G. bellulus* by Peck in BUF and NY, the other herbaria housing his material. One of the specimens from NYS is labelled as type or syntype (Lewis Co., Lowville). Together with the specimen from Canada collected by J.M. Macoun (see Tab. 1 and the collections studied) it represents quite another species (having small spores) than the remaining ones (having much larger spores). The latter collections probably represent a species close to *Gymnopilus picreus* (which should be judged by an American monographer of *Gymnopilus*).

Tab. 1. Comparison of the spore size in collections of *Gymnopilus bellulus* at NYS identified by C.H. Peck

NYS specimens Peck identified as <i>NAUCORIA BELLULA</i> (for details see Collections studied)	SPORE SIZE IN μm (specimens with <i>small</i> spores)	SPORE SIZE IN μm (specimens with <i>large</i> spores)
Lowville (lectotype)	(5.2–)5.6–6.4 x 3.2–3.6	
Canada	4.8–5.6 x 3.2–3.6	
Adirondacks Mts.		8.4–9.6 x 6.0–6.4
Forestburgh		(8.8–)9.2–9.6 x 6.0–6.4(–6.8)
Warrensburg		(8.0–)8.8–9.2 x 5.6–6.8
Catskill Mts.		8.8–9.6 x 6.0–6.4
Lewis Co., Greig		9.2–10.0 x 6.0–6.4
North Elba		(8.4–)8.8–9.6 x 6.0–6.8

As all collections were identified by Peck, it seems that he did not have a clear concept of his new species. Similarly, L.R. Hesler, a monographer of *Gymnopilus*, writes (Hesler 1969: 38) that „Peck's type is confusing, it appears that the labels of the type and of a collection of another species have been interchanged. In the collection marked type and which we examined, the spores are 8–9.5 x 5–5.5 μm – much too large for *G. bellulus*“.

All collections I had on loan except for the syntype from Lowville and the Canadian collection (see above) really have the large spores as indicated by Hesler. However, the syntype from Lowville (for type study see above) well agrees with both the original description by Peck and the current concept of *Gymnopilus bellulus*, which is a species

with spores measuring about $4.5\text{--}6.5 \times 3\text{--}4 \mu\text{m}$. It is hard to explain why Hesler found much larger spores in the type specimen. However, he does not indicate exactly which type collection he studied (he only writes “collection marked type which we examined”). It could be a collection from the second locality given by Peck (1873) in his original description (Sandlake).

I asked current NYS, curator John Haines whether such a collection is available at NYS. He wrote me that „we do not have the second presumed Sandlake syntype (presumed because it was mentioned in the protologue)“ and that the specimen „has not been seen since I came to the museum in 1969“.

Fortunately, the syntype from Lowville is available and agrees well with the current concept of *Gymnopilus bellulus*. Consequently, it is logical to designate it as the lectotype of *Gymnopilus bellulus*. In this way, the current concept of *G. bellulus* will be fixed in spite of the discrepancies in the material collected by Peck.

Another bit of helpful information is a painting made when the Lowville specimen was fresh. John Haines scanned and sent it to me via Internet. According to him, „it bears the same collection number as the Lowville specimen and was removed from that box some years ago“. The depicted fungus looks exactly like *Gymnopilus bellulus*, which I know well from the field in Europe (in paragraph „Collections studied“ I cite only a limited selection of representative specimens from Europe which I revised for comparison with the type).

By the way, the original envelope of the syntype from Lowville (made from a newspaper from Peck's time) is labelled *Agaricus (Naucoria) obnoxius* (original hand writing by Peck?). It was probably a provisional name which was changed to *Agaricus bellulus* in the original publication. John Haines confirmed to me that he recorded that provisional name in Peck's field notes.

Collections studied (representing *G. bellulus*): USA, New York, Lowville, Lewis Co., Sept., leg. C.H. Peck 68 (NYS: mycology type database 450; lectotype of *Gymnopilus bellulus*, designated here, see paragraph Lectotype). – Canada, 22 Aug 1892, leg. J.M. Macoun, det. C.H. Peck as *Naucoria bellula* (NYS). – Austria, Niederösterreich, Hohenberg, Lagsattel, *Abies*, 30 June 1992, leg. A. Hausknecht (WU 10824). – Austria, Niederösterreich, Lunz/See, Rotwald: NSG Kleiner Urwald, wood of conifer (*Abies*?), 29 Aug 1996, leg. A. Hausknecht (WU 16262). – Czech Republic, Beskydy Mts., Morávka, Travný, *Picea abies*, on decayed trunk, 17 Sep 1987, leg. Z. Pouzar (PRM 852262). – Czech Republic, Novohradské hory Mts., Žofínský prales virgin forest, *Fagus*, on trunk, 21 Sep 1991, leg. V. Antonín (BRNM 553290). – Czech Republic, Šumava Mts., Mt. Boubín, Boubínský prales virgin forest, Aug 1936, leg. J. Herink (PRM 27788). – Czech Republic, Šumava Mts., České Žleby, Mt. Spáleniště, *Abies alba*, on decayed trunk among mosses, 26 Oct 2002, leg. J. Holec (PRM 900962). – Czech Republic, Šumava Mts., Nová Pec, Mt. Plechý, *Picea abies*, on decayed trunk, 26 Aug 1996, leg. J. Holec, 317/96 (PRM 889100). – Italy, Trento, Paneveggio, wood of a conifer, 4 Oct 1989, leg. R. Schütz (WU 8143). – Ukraine, Eastern Carpathians, near Dilove („Trebušany“), Berlebash („Berlebaš“) stream valley, *Picea abies*, Aug 1937, leg. A. Pilát (PRM 488229).

Collections representing other species (close to *G. picreus*): USA, New York, North Elba, Sept., leg. C.H. Peck, det. C.H. Peck as *Naucoria bellulus* (NYS) – ditto, Catskil

Mts. (NYS). – ditto, Warrensburg, Oct. 19 (NYS). – ditto, Forestburgh (NYS). – ditto, Lewis Co., Greig (NYS). – ditto, Adirondack Mts., on mossy hemlock trunk (NYS).

***Gymnopilus microsporus* (Singer) ex Singer**

≡ *Fulvidula microspora* Singer, Rev. Mycol. 2: 239, 1937 (invalid name, as the generic name *Fulvidula* is invalid, see e.g. Donk 1962). Singer (1937) published the name as a „nomen novum“ for *Flammula liquiritiae* (Pers.) P. Kumm. sensu Bres., Icon. mycol., vol. 16, text + tab. 783, 1930. This is, however, not a nomen novum (see ICBN Art. 33, Note 2). *Fulvidula microspora* must be treated as an invalid name of a new species. The valid publication was made later:

≡ *Gymnopilus microsporus* (Singer) ex Singer, Lilloa 22: 561, 1951 („1949“).

Holotype: Bresadola, Icon. mycol., vol. 16: tab. 783, 1930 (illustration serving as holotype); as the holotype is ambiguous and cannot be critically identified for purposes of the precise application of the name, an interpretative type – epitype – is selected here (for discussion see below).

Epitype (selected here, explanations of data from the original label are given in brackets): Russia (former USSR), Caucasus, Kavkazskiy Zapovednik (north-western part of the Caucasus), ad truncos putridos coniferarum, leg. L.N. Vasilieva in 1936 (LE 17635), for discussion see below.

Revision of *Gymnopilus microsporus* sensu Singer

Macrocharacters: Singer (1937, 1951) refers to Bresadola (Icon. mycol., vol. 16, text + tab. 783, 1930).

Epitype study (the material is poorly preserved, with many collapsed cells): Spores small, 4.4–4.8 x 2.8–3.2 μm , E = 1.38–1.71, Q = 1.51, yellow in KOH, ellipsoid in front view, ellipsoid-amygdaliform with a slight but distinct suprahilar depression in side view, wall yellow-brown, thick, medium to coarsely verrucose, slightly dextrinoid (with pale reddish-brown tinge in Melzer's reagent), mature spores acyanophilous or only slightly cyanophilous, the immature ones or those with a broken wall distinctly cyanophilous. Basidia mostly collapsed, 4-spored, 16–22 x 4–5 μm , cylindrical, with long sterigmata, often filled with rusty brown pigment. Cheilocystidia difficult to find, probably collapsed, about 20–25 x 5–6 μm , narrowly lageniform with a slightly capitate apex, filled with homogeneous rusty brown pigment. Pleurocystidia not observed. Pileus cuticle (observed on surface only in order not to damage the fruitbodies) a cutis of hyphae (5–)8–12(–14) μm broad, cells cylindrical or slightly inflated, terminal elements clavate, up to 24 μm broad, wall coarsely rusty brown incrustated in a “tiger” pattern, pileocystidia not observed. Stipe made up of cylindrical hyphae 4–10.5 μm broad, cuticle a cutis of cylindrical hyphae 2.5–4 μm broad, at places (rarely) with cylindrical outgrowths up to 5 μm long, in mass rusty brown, wall with rusty brown membranous pigment, not heavily incrustated. Clamp connections present in all tissues.

Conclusion: The specimen LE 17635 represents the species *Gymnopilus bellulus* (Peck) Murrill. The same opinion was expressed by Emma L. Nezdoiminogo on a revision label on the envelope of LE 17635 written in 1985. However, her conclusion was not published (personal communication). If only the herbarium specimens from then Caucasus and its microcharacters are considered, then *Gymnopilus microsporus*

sensu Singer (1937) represents a synonym of *Gymnopilus bellulus*.

Discussion: Although there exists a herbarium specimen (LE 17635, for details see paragraph Epitype) on which the name *G. microsporus* is based (the specimen is labelled „holotypus“ in LE), it is not the holotype. The name *Gymnopilus microsporus* is validated by Bresadola's Latin description as Singer (1937, 1951) did not provide description, Latin diagnosis, or designation of type in his publications. Consequently, elements from the context of the validating description should be used for typification (see ICBN Art. 7.7 Ex. 4).

Flammula liquiritiae (Pers.) P. Kumm. sensu Bresadola, on which the name *G. microsporus* is based, is a fungus that is hard to interpret. In its description and illustration, Bresadola presents a fungus with a pholiotoid to gymnopiloid habit and small spores which may be smooth or minutely verrucose (?). The cystidia he presents are typically pholiotoid (see the same conclusion by Singer in Moreno & Esteve-Raventós 1990: 288). They are too large for *Gymnopilus* (50–60 x 10–15 μm , whereas 20–40 x 5–10 μm is typical for European species of *Gymnopilus*) and lageniform-fusiform (in *Gymnopilus*, the cystidia are more or less capitate). I do not know such a fungus among European species of *Gymnopilus* and it is neither mentioned in any critical treatments of *Gymnopilus* in Europe. Such a mixture of characters really could be a result of erroneous observations by Bresadola (see also Singer in Moreno & Esteve-Raventós 1990: 288) or because his illustration and description of macrocharacters is based on other material than the description of microcharacters.

I contacted herbaria housing the collections by Bresadola (S, BPI, M, TR) to ask if there are any collections of *Flammula liquiritiae* identified by him. There are no specimens in S, BPI, and M, but two collections are available at TR (Museo Tridentino di Scienze Naturali, Italy). They were collected by Julius Schaeffer in Germany (Potsdam), identified by Bresadola (see the collections studied) and most probably used for his description of *Flammula liquiritiae*. At first I thought that they represent syntypes of *Gymnopilus microsporus* from which the lectotype could be selected. However, some data from their labels are not in accordance with data in Bresadola's description (Tab. 2).

Tab. 2. Differences between characters given by G. Bresadola on labels of *Flammula liquiritiae* in TR herbarium and in his description published in *Iconographia mycologica*.

CHARACTER	LABEL (TR B/228, TR B/239)	DESCRIPTION (Bresadola 1930: tab. 783)
Substrate	in pinetis ad terram (= on soil in <i>Pinus</i> forests)	ad truncos coniferarum in silvis (= on trunks of conifers in forests)
Size of basidia	24–26 x 6–7 μm	28–32 x 6–8 μm
Spore size	5–6 x 3.5–4 μm	4.5–6 x 3–4 μm
Distribution or location	Potsdam (Germany)	Europe, Asia (Siberia)

It seems that the description by Bresadola was based not only on the two collections studied but also on other collections (e.g. from Asia), as the data in the description are broader or different than those on labels.

A careful microscopic revision of the two collections from TR clearly showed that they represent in fact *Pholiota mixta* (Fr.) Kuyper & Tjall.-Beuk. The spores are smooth, measure 6.0–6.5(–6.8) x 3.4–4 μm and numerous cheilo- and pleurocystidia of lageniform-fusiform shape are present. I am quite certain with this identification as I know the species well (see Holec 2001a: 105–110). The assumption on phliotoid cystidia in *Flammula liquiritiae* expressed above proved to be correct.

It is unclear why Bresadola described the spores as smooth or minutely verrucose. This is either an observation error (which is quite understandable) or a consequence of the fact that other collections belonging e.g. to *Gymnopilus* and having verrucose spores were used for the description of his *Flammula liquiritiae*.

Generally, the description and illustration of *Flammula liquiritiae* (Pers.) P. Kumm. sensu Bresadola (1930) is hard to interpret and the only collections available represent *Pholiota mixta* (Fr.) Kuyper & Tjall.-Beuk. The discrepancies between the description and labels of these herbarium specimens do not enable to consider them types.

In such a situation, the holotype of *Gymnopilus microsporus* is represented by the illustration by Bresadola (Icon. mycol., vol. 16: tab. 783, 1930) – the only type material available. It is interesting that the illustration is cited by Hesler (1969: 65) as typical of *Gymnopilus liquiritiae*, although he mentions much larger spores in his description than Bresadola.

With respect to all these discrepancies, it is better to use the collection from LE identified by Singer for interpretation of the name *G. microsporus* (see the microscopic study above). Singer himself (in Moreno & Esteve-Raventós 1990: 288) confirms that he knows the discrepancies in Bresadola's publication and that he follows his own concept of *G. microsporus* (based on material from the Caucasus). In this situation, I decided to designate the collection from LE as the epitype. If such a concept is accepted, then *Gymnopilus microsporus* (Singer) ex Singer is a species identical with *Gymnopilus bellulus* (Peck) Murrill and the name must be considered a synonym of *G. bellulus*. In my opinion, this is the best treatment of the name *G. microsporus*.

Collections studied: Russia, Caucasus, Kavkazskiy Zapovednik, ad truncos putridos coniferarum, leg. L.N. Vasilieva in 1936 (LE 17635, epitype of *Gymnopilus microsporus*, selected here, see paragraph Epitype). – Germany, Potsdam, in pinetis ad terram, leg. J. Schaeffer, det. G. Bresadola (TR: herbarium Bresadola B/239). – ditto (TR: herbarium Bresadola B/228).

Acknowledgements

I thank Zdeněk Pouzar (Praha), Klaus Høiland (Oslo), and Vladimír Antonín (Brno) for their valuable advice and comments on the manuscript. Curators of the following herbaria are kindly acknowledged for arranging loans from their institutions: LE, NYS, MICH, TR or providing information: BUF, M, NY, S. The work was financially supported by the Grant Agency of the Czech Republic (project no. 206/01/P05) and the Ministry of Culture of the Czech Republic (MK0CEZ99F0201).

Literature cited

- Bon M, Roux P (2002): Le genre *Gymnopilus* P. Karst. en Europe. – In: Fungi non delineati, vol. 17: 1-52, Alassio.
- Breitenbach J, Kränzlin F (2000): Pilze der Schweiz. Band 5, Blätterpilze 3. Teil, *Cortinariaceae*. – 340 p., Luzern.
- Bresadola G (1930): Iconographia mycologica. Vol. 16. – Tab. 750-800, Milano.
- Donk MA (1962): The generic names proposed for Agaricaceae. – Beih. Nova Hedwigia 5: 1-320.
- Guzmán-Dávalos L (2003): Type studies of *Gymnopilus* (Agaricales) I. – Mycotaxon 86: 395-423.
- Hesler LR (1969): North American Species of *Gymnopilus*. – Mycologia Memoir 3: 1-117.
- Høiland K (1990): The genus *Gymnopilus* in Norway. – Mycotaxon 39: 257-279.
- Holec J (2001a): The genus *Pholiota* in central and western Europe. – In: Libri Botanici, vol. 20: 1-220, Eching.
- Holec J (2001b): Remarks to the taxonomy of *Gymnopilus josserandii* based on records from the Bohemian Forest (Czech Republic). – Czech Mycol. 53(2): 131-137.
- Holec J (2002): The genus *Gymnopilus* (Basidiomycetes, Agaricales) in the Czech Republic. – In: IMC7, Book of abstracts, p. 207 (abstract of poster presented at The 7th International Mycological Congress, Oslo 11-17 August 2002).
- Holec J, Antonín V, Graca M, Moreau P-A (2003): *Gymnopilus igniculus* – find from the Czech Republic and notes on its variability. – Czech Mycol. 55(3-4): 161-172.
- Holmgren PK, Holmgren NH, Barnett LC (1990): Index herbariorum. Part I: The herbaria of the world. Ed. 8. – 693 p., New York.
- Keller G, Moser MM (2001): Die *Cortinariaceae* Österreichs. Catalogus Florae Austriae, III. Teil, Pilze, Heft 2, Agaricales: *Cortinariaceae*. – In: Biosystematics and ecology series, no. 19: 1-220, Wien.
- Kotlaba F, Pouzar Z (1964): Preliminary results of the staining of spores and other structures of Homobasidiomycetes in cotton blue and its importance for taxonomy. – Feddes Repertorium 69: 131-142.
- Kühner R, Romagnesi H (1953): Flore analytique des champignons supérieurs. – 557 p., Paris.
- Ludwig E (2000): Pilzkompendium. Band 1. Abbildungen. – 192 p., Eching.
- Ludwig E (2001): Pilzkompendium. Band 1. Beschreibungen. – 758 p., Eching.
- Moreno G, Esteve-Raventós F (1990): *Gymnopilus microsporus* (Sing.) Sing. y *Simocybe iberica* sp. nov. en España peninsular. – Riv. Micol. 33: 287-292.
- Moser M (1983): Die Röhrlinge und Blätterpilze. – In: Kleine Kryptogamenflora, ed. 5, vol. 2b/2: 1-533, Stuttgart.
- Orton PD (1993): *Gymnopilus*. – In: Watling R, Gregory NM, British fungus flora. Agarics and Boleti, vol. 6: 58-72, Edinburgh.
- Peck CH (1873): Descriptions of new species of fungi. – Bull. Buffalo Soc. Nat. Sci. 1: 41-72.
- Peck CH (1874): Report of the botanist. – Annual Rep. New York State Mus. 26: 35-91.
- Singer R (1937): Notes sur quelques Basidiomycètes. III^e série. – Rev. Mycol. 2: 226-242.
- Singer R (1951): The „Agaricales“ (mushrooms) in modern taxonomy. – Lilloa 22: 1-832 („1949“).
- Singer R (1986): Agaricales in modern taxonomy. – 981 p., Koenigstein.

A new species of *Pucciniastrum* on *Enkianthus campanulatus* from Japan*

YING-MEI LIANG¹, CHENG-MING TIAN²,
KAZUYUKI HIRATSUKA³ & MAKOTO KAKISHIMA¹

kaki@sakura.cc.tsukuba.ac.jp

¹ Graduate School of Life and Environmental Sciences, University of Tsukuba
Ibaraki 305-8572, Japan

² The Key Laboratory for Silviculture and Conservation of Ministry of Education,
Beijing Forestry University, Beijing 100083, China

³ Department of Environment and Natural Sciences, Yokohama National University
Kanagawa 240-8501, Japan

Abstract—A new species of rust fungus, *Pucciniastrum hakkodaense* on *Enkianthus campanulatus*, is described from Japan. This species is characterized by aculeate ostiolar celles of peridia and uniformly echinulate urediniospores.

Key words—Basidiomycota, *Pucciniastraceae*, *Pucciniastrum pyrolae*, *Uredinales*, taxonomy

Introduction

Pucciniastrum Otth (1861) is a worldwide genus. Most species are known to have a heteroecious life cycle, and their uredinial and telial stages mainly occur in dicotyledonous plants, and their spermogonial and aecial stages on the *Pinaceae* (*Abies*, *Picea* and *Tsuga*). Recently, Cummins and Hiratsuka (2003) placed the *Pucciniastrum* as separate genus from *Thekopsora* Magnus (1875) and *Calyptospora* J. G. Kühn (1869) based on the position of the telia in the plant tissue. *Pucciniastrum* produces its telia underneath the epidermis of host plants, while *Thekopsora* and *Calyptospora* produce them within the epidermal cells (Pady 1933, Sato et al. 1993).

In Japan, the taxonomic studies of *Pucciniastrum* have been extensively carried out by Hiratsuka (1927, 1930, 1936, 1958) and 21 species were reported in Japan (Hiratsuka et al. 1992). The specific distinctions have to a considerable extent been based on the host plants attacked, and the taxonomic identity of species is sometimes artificial. During the study on morphology and phylogeny of *Pucciniastrum* spp. in Japan we examined two specimens borrowed from the Hiratsuka Herbarium in Tokyo (HH103630, HH103631), which were collected by Hiratsuka et al. in Aomori prefecture, and identified as

*Contribution no. 197, Laboratory of Plant Parasitic Mycology, Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan.

Pucciniastrum kusanoi Dietel on *Clethra barbinervis* Sieb. et Zucc. However, we found that the host plant of these specimens was misidentified and it was *Enkianthus campanulatus* (Miq.) G. Nicholson in the *Ericaceae*. Observations with light (LM) and scanning electron microscopy (SEM) showed that these two specimens morphologically differed from *P. kusanoi* and other species in the genus (Arthur 1934, Hiratsuka et al. 1992, Kuprevich et al. 1957, Wilson and Henderson 1966, Ziller 1974). Therefore, we describe it as a new species.

Taxonomic description

***Pucciniastrum hakkodaense* Y. M. Liang & Kakishima, sp. nov. Fig. 1**

Spermogoniis et aeciis ignotis; urediniis hypophyllis, subepidermalibus, sparsis vel rarius aggregatis, saepe in superficie folii totalis dense dispersis, minutis, rotundatis vel ellipsoideis, 0.08–0.25 mm diam., luteo-brunneis vel pallide brunneis, aliquantum pulveraceis; peridio hemisphaerico, firmo, apice dehiscente, ex cellulis supernis minutis irregulariter polygonalibus cellulis lateralibus radiatim elongatis composito, cellulis ostiolaribus ellipsoideis vel rotundatis superne grosse eaculeatis ad basim crassis praedito; urediniosporis oblongis vel clavato-oblongis, $23.5\text{--}34.4 \times 10.2\text{--}15.7\mu\text{m}$, episporio echinulato fere hyalino, $0.8\text{--}1.5\mu\text{m}$ crasso; telii plerumque hypophyllis, subepidermalibus, planis, nervis foliae limitatis, minutis, flavo-brunneis; teliosporis solitariis vel irregulariter aggregatis aut lateraliter confertim conjunctis, subglobosis vel ellipsoideis, $2\text{--}5\text{-cellularibus}$, $16.5\text{--}35.0\mu\text{m}$ altis, episporio subhyalino vel pallide brunneolo, cinnamomeo-brunneo tenui levi.

Holotypus hic designatus: HH103630 in foliis *Enkianthi campanulati* (Miq.) G. Nicholson (*Ericaceae*), Suirennume–Sukayu, Hakkoda Mts., Aomori Pref. in Japonia, Aug. 28, 1953, a N. Hiratsuka, Shoji Sato & T. Yamagata leg. in Herbario Hiratukanorum, Tokyo conservatus.

Spermogonia and aecia unknown. Uredinia hypophyllous, subepidermal, scattered or rarely grouped, often thickly scattered over the whole leaf surface, round or ellipsoid, minute, up to 0.08–0.25 mm in longest axis, yellowish brown or pale yellow, at last somewhat pulverulent; peridia hemispherical, firm, dehiscent from an apical pore, upper peridial cells small, isodiametrical or irregular, lateral ones radially elongate, walls smooth, nearly colorless; ostiolar cells ellipsoid or roundish, coarsely aculeate above, greatly thickened below; urediniospores oblong or clavate-oblong, $23.5\text{--}34.4 \times 10.2\text{--}15.7\mu\text{m}$, spore wall uniformly about $0.8\text{--}1.5\mu\text{m}$ thick, nearly colorless, minutely echinulate. Telia hypophyllous, subepidermal, flat, minute, limited by veins, generally in dense clusters, yellow to yellowish brown; teliospores forming under the epidermis, mostly loosely aggregated, often compacted laterally under the epidermis, subglobose or ellipsoid, $16.5\text{--}35.0\mu\text{m}$ high, walls uniformly thin, smooth, cinnamon-brown.

Holotype: on *Enkianthus campanulati* (Miq.) G. Nicholson (*Ericaceae*), Suirennume–Sukayu, Hakkoda Mts., Aomori Pref. in Japan. (Aug. 28, 1953, N. Hiratsuka, Shoji Sato & T. Yamagata; HH103630, Hiratsuka Herbarium, Tokyo).

Other specimen examined: on *Enkianthus campanulatus* (Miq.) G. Nicholson (*Ericaceae*), Japan, Hakkoda Mts., Aomori (N. Hiratsuka, Shiji Sato & T. Yamagata; HH103631).

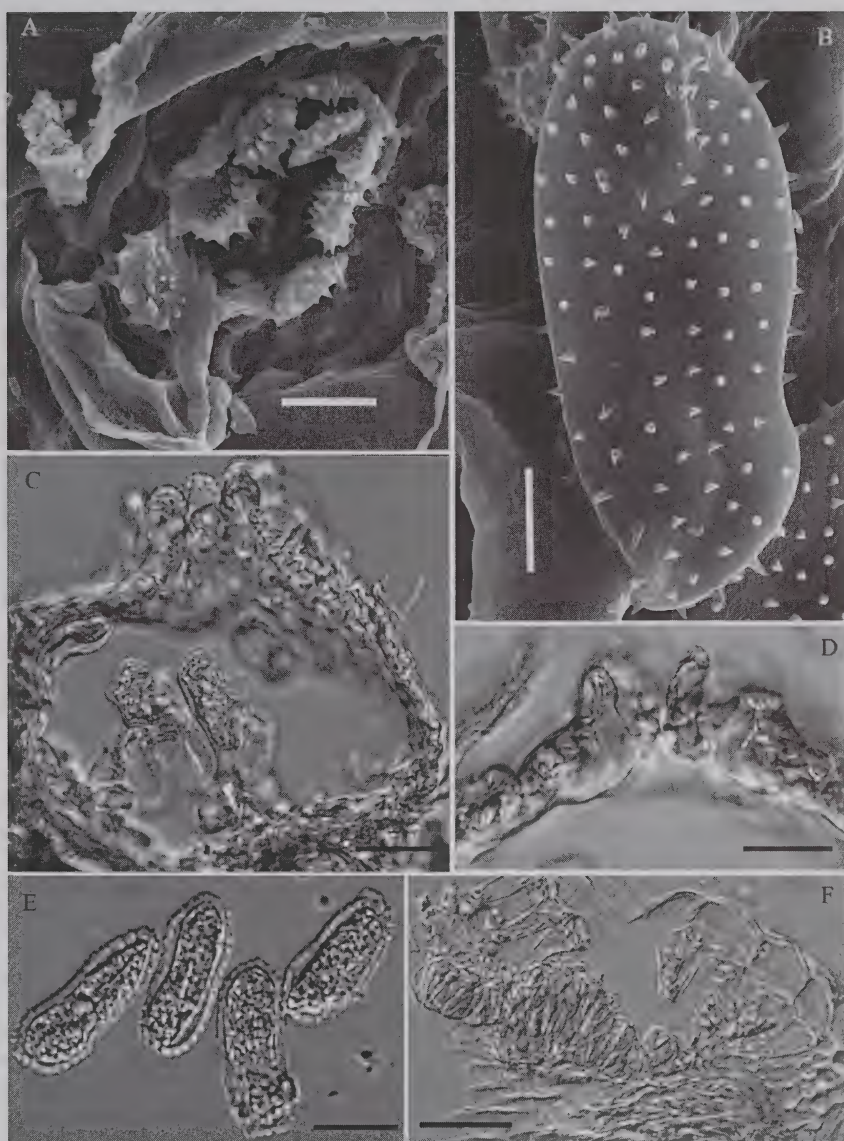


Fig.1. *Pucciniastrum hakkodaense*. A. Ostiolar cells of peridia observed by SEM (Bar=15µm); B. Uniformly echinulate urediniospores (Bar=5µm); C. Uredinia (Bar=15µm); D. Ostiolar cells (Bar=20µm); E. Urediniospores (Bar=12µm); F. Subepidermal telia (Bar=20µm).

Discussion

The present species has characteristic peridia with ostiolar cells in uredinia (Fig. 1A, 1C, 1D), subepidermal telia, and teliospores with two to four cells divided by septa (Fig. 1F). From these morphological characteristics this species is recognized as a *Pucciniastrum* (Hiratsuka 1958).

Hiratsuka (1958) reported 23 species of *Pucciniastrum* and these were separated into four morphological groups based on the structure of ostiolar cells of peridia in the uredinia. The first group including three species is characterized by coarsely or sparsely aculeate ostiolar cells. The second group including two species is characterized by the minutely echinulate ostiolar cells which sometimes became smooth in wet conditions. The ostiolar cells of the third group is obscure and two species are included in this group. The fourth group has smooth ostiolar cells and contains 16 species that are separated based on differences of host plants because of morphological similarities among these species.

This species belongs to the first group because of coarsely aculeate ostiolar cells of the peridia (Fig. 1A). Three species *P. pyrolae* Dietel ex Arthur, *P. americanum* (Farl.) Arthur, and *P. arcticum* Tranzschel have been reported in this group (Arthur 1934, Hiratsuka 1936, 1958, Hiratsuka et al. 1992, Kuprevich et al. 1957, Ziller 1974). *Pucciniastrum hakkodaense* is clearly different from the latter two species in the size and the shape of urediniospores as well as host relations. The urediniospores size of *P. americanum* and *P. arcticum* is $15\sim 28 \times 10\sim 18 \mu\text{m}$ and $17\sim 27 \times 12\sim 16 \mu\text{m}$, respectively, which are smaller than those of *P. hakkodaense* ($23.5\sim 34.4 \times 10.2\sim 15.7 \mu\text{m}$). Moreover, *P. americanum* and *P. arcticum* produce uredinia and telia on *Rosaceae*.

Pucciniastrum hakkodaense is similar to *P. pyrolae* in peridial structure of uredinia and the shape of urediniospores. However, the urediniospore surface of *P. hakkodaense* is uniformly echinulate without smooth area (Fig. 1B), whereas that of *P. pyrolae* has smooth area (Fig. 2H). Many herbarium specimens of *P. pyrolae*, collected from USA, Canada, Russia and Japan, and deposited in the Mycological Herbarium, Graduate School of Life and Environmental Sciences, the University of Tsukuba, Japan (TSH-R017, 8755, 8773, 12368, 12346, 12721, 13205, 13333, 13339, 18072, 18073, 18159, 18352), were observed with LM and SEM. All these specimens have smooth area in the surface of urediniospores. Furthermore, the urediniospores size of *P. pyrolae* is larger ($23.4\sim 42.5 \times 10.8\sim 19 \mu\text{m}$) than that of *P. hakkodaense*. In addition, *P. hakkodaense* and *P. pyrolae* parasitize different hosts. *P. hakkodaense* is parasitic on *Enkianthus campanulatus* of *Ericaceae*, and *P. pyrolae* on *Pyrolaceae*.

Acknowledgments

We wish to express our thanks to Hiratsuka Herbarium, Tokyo, Japan for the loan of specimens. We are also grateful to Prof. Toru Nakamura, University of Tsukuba for the identification of host plants and Dr. Ken Katumoto for the checking Latin description. We thank Dr. J. Y. Zhuang, Academia Sinica, China and Dr. Y. Ono, Ibaraki University, Japan for critically reading the manuscript.

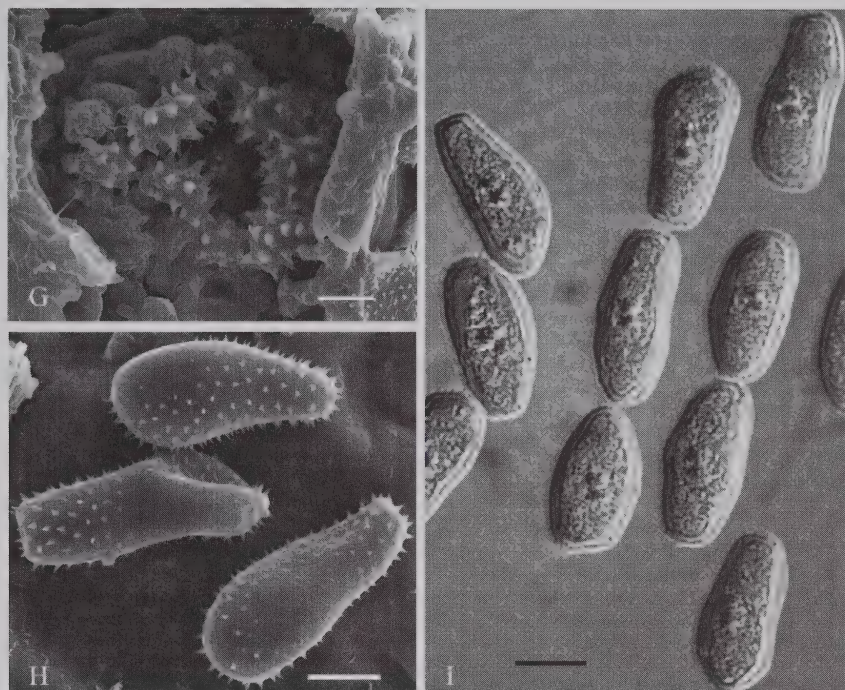


Fig. 2. *Pucciniastrum pyrolae*. G.. Ostiolar cells of peridia observed by SEM (Bar=7.5 μ m); H.. Urediniospores, note smooth area (Bar=10 μ m); I.. Urediniospores (Bar=15 μ m).

Literature Cited

- Arthur JC. 1934. Manual of the rusts in United States and Canada. Purdue Research Found., Lafayette, Ind. Reprinted with a supplement by Cummins GB (1962). Hafner Publishing Co., New York.
- Cummins GB, Hiratsuka Y. 2003. Illustrated genera of rust fungi. Third ed. The American Phytopathological Society, St. Paul, MN. APS Press, St. Paul, MN.
- Hiratsuka N. 1927. Beitrage zu einer Monographie der Gattung *Pucciniastrum* Otth. The Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. XXI, pt. 3. 63-120.
- Hiratsuka N. 1930. *Pucciniastrum* of Japan. The Botanical Magazine Tokyo. 44: 261-284.
- Hiratsuka N. 1936. A Monograph of the *Pucciniastreae*. Tottori Agricultural College, Tottori, Japan. 1-374.
- Hiratsuka N. 1958. Revision of taxonomy of the *Pucciniastreae*. Kasai Publ. Print. Co., Tokyo.
- Hiratsuka N, Sato S, Katsuya K, Kakishima M, Hiratsuka Y, Kaneko S, Ono Y, Sato T, Harada Y, Hiratsuka T, Nakayama K. 1992. The rust flora of Japan. Tsukuba Shuppankai, Tsukuba, Ibaraki, Japan.
- Kühn J. 1869. *Calypsozpora* nov. gen. Uredinearum. (Hedwigia, VIII: 81).
- Kuprevich VF, Tranzschel VG. 1957. Cryptogamic plants of the USSR. Vol. IV. Rust Fungi. 1. Family *Melampsoraceae*. Edited by Savich VP. Academy of Sciences of the USSR, Komarov Inst. Bot., Moskva-Leningrad. Translated by E. Rabinovitz, Jerusalem, 1970.

- Magnus P. 1875. Über die Familie der *Melampsoreae* und ihre Gattungen. Sitzungsber. Ges. Naturf. Freunde Berl. P. 57-60.
- Pady SM. 1933. Teliospore development in the *Pucciniastraceae*. Can. J. Res. 9: 458-485.
- Sato S, Katsuya K, Hiratsuka Y. 1993. Morphology, taxonomy and nomenclature of *Tsuga-Ericaceae* rusts. Trans. Mycol. Soc. Japan 34: 47-62.
- Wilson M, Henderson DM. 1966. British Rust Fungi. Cambridge University Press, Cambridge.
- Ziller WG. 1974. The tree rusts of western Canada. Environ. Can., Can. For. Serv., Victoria, BC. Publ. 1329. p174-193.

***Oidium moluccanum* nov. sp. causing powdery mildew on *Aleurites moluccanus* in East Timor**

J. R. LIBERATO ¹, P.M. STEPHENS ² & R. G. SHIVAS ¹

jose.liberato@dpi.qld.gov.au roger.shivas@dpi.qld.gov.au

¹ Department of Primary Industries & Fisheries, Plant Pathology Herbarium
80 Meiers Rd, Indooroopilly, Qld 4068, Australia

² Australian Quarantine and Inspection Service, NAQS
PO Box 3000, Darwin, NT 0801, Australia

Abstract — *Oidium moluccanum* nov. sp. is described causing powdery mildew on *Aleurites moluccanus* in East Timor.

Key words — *Erysiphaceae*, new species

Introduction

Candle-nut (*Aleurites moluccanus* (L.) Willd., *Euphorbiaceae*, often cited as *A. moluccana* (L.) Willd.) is a medium-sized tree up to 20 m tall, native to south-east Asia and widely distributed in the tropics. It is a source of candle-nut oil and also used in curries and commercial shampoos (Mabberley 1998).

Pressed and dried leaves of *A. moluccanus* collected in East Timor, were sent to herbarium BRIP. The leaves had chlorotic lesions on the adaxial laminas and were covered by a powdery mildew on the corresponding abaxial surface. The fungus was a new anamorphic *Oidium* (Ascomycota: *Erysiphales*).

Taxonomic Description

***Oidium moluccanum* Liberato & R.G. Shivas sp. nov.**

FIGURES 1-22

Maculae in foliis vivis. *Mycelium* hypophyllum. *Hyphae* *superficiales* hyalinae, flexuosae, ramosae, septatae, 3–10 µm latae, aliquando hyphae tumidus. *Appressoria* lobata. *Conidiophora* ex hyphis superficialibus oriunda, non ramosa, cylindrica, 26–192 x 4–10 µm, 0–2(–4) septata, hyalina, cellulis pedibus, 26–46 x 4–10 µm, rectis vel ad basim sinuosis, aliquando tumidus. *Conidia* solitaria, ellipsoidea vel subcylindra 22–50 x 12–22 µm; hyalina, laevia, tubis germinalibus terminalibus, modice longis, appressoriis lobatis.

Etymology: from the host *Aleurites moluccanus*

Holotype here designated: on living leaves of *Aleurites moluccanus*, East Timor, Chai Lore, 127°00.816' E, 08°37.909' S, 11 April 2003, P.M. Stephens, BRIP 45348.



Figs 1–21. *Oidium moluccanum* (from holotype). **Figs 1–11.** Pseudoidium-type conidiophores and a lobed, mycelial appressorium (arrowed). **Fig 12.** Conidium. **Figs 13–15.** Conidia and germ tubes. **Fig. 16.** Swollen conidiophore foot-cell. **Figs 17–21.** Swollen conidiophore or hyphal cell (sc) and conidium (co). (bar = 20 μ m).

Lesions on living leaves, chlorotic, irregular, affecting large areas of the lamina adaxially; diseased areas corresponding to areas with powdery fungal growth abaxially. Superficial colonies, with abundant sporulation. Superficial *hyphae* branched, septate, hyaline, 3–10 μ m wide, sometimes with hyphal swellings, mycelial appressoria multilobed. *Conidiophores* produced from the external mycelium, hyaline, smooth, 26–192 x 4–10 μ m, 0–2(–4) septate, foot-cells straight or flexuous, 26–46 x 4–10 μ m, sometimes swollen (up to 20 μ m wide). *Conidia* produced singly at the apex of the

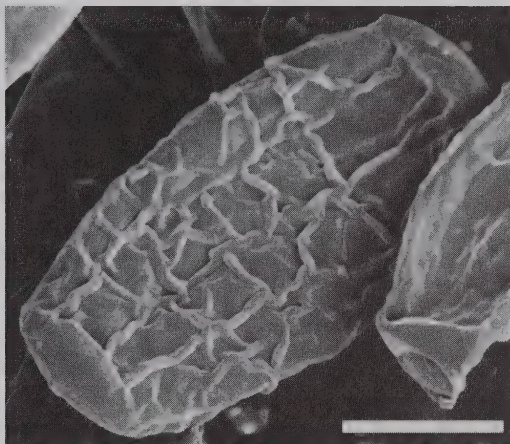


Fig 22. *Oidium moluccanum* (from holotype). Conidial surface pattern seen under SEM (bar = 10 μ m).

conidiophores, subcylindric, ovoid or ellipsoid, 22–50 $\times$ 12–22 μ m, hyaline, smooth. Germ tube, one at an end of the spore, small to moderately long (up to twice the length of the conidium), ending in a lobed or apically swollen appressorium. *Teleomorph*: not found.

Discussion

According to Braun (1987), there are 23 species of powdery mildew in the subfamily *Erysiphoideae* (anamorph *Oidium*) on plants in the *Euphorbiaceae*. Twelve are species of *Erysiphe* DC. emend. U. Braun & S. Takam.: 1. *Erysiphe acalyphae* (F.L. Tai) R.Y. Zheng & G.Q. Chen, 2. *Erysiphe alchorneae* (R.Y. Zheng & G.Q. Chen) U. Braun & S. Takam. ($\equiv$ *Uncinula alchorneae* R.Y. Zheng & G.Q. Chen), 3. *Erysiphe aleuritis* (C.T. Wei) U. Braun & S. Takam. ($\equiv$ *Uncinula miyabei* var. *aleuritis* C.T. Wei), 4. *Erysiphe andina* (Speg.) U. Braun, 5. *Erysiphe bischofia* (C.T. Wei) U. Braun & S. Takam. ($\equiv$ *Uncinula bischofia* C.T. Wei), 6. *Erysiphe euphorbiacearum* (R.Y. Zheng & G.Q. Chen) U. Braun & S. Takam. ($\equiv$ *Uncinula euphorbiacearum* R.Y. Zheng & G.Q. Chen), 7. *Erysiphe euphorbiae* Peck, 8. *Erysiphe euphorbiicola* U. Braun & S. Takam. ($\equiv$ *Microsphaera euphorbiae* Berk. & M.A. Curtis), 9. *Erysiphe jatrophae* Doidge, 10. *Erysiphe malloti* Zhi X. Chen & R.X. Gao, 11. *Erysiphe phyllanthi* (S. Tanda & U. Braun) U. Braun & S. Takam. ($\equiv$ *Microsphaera phyllanthi* S. Tanda & U. Braun), and 12. *Erysiphe securinegae* (F.L. Tai & C.T. Wei) U. Braun & S. Takam. ($\equiv$ *Microsphaera securinegae* F.L. Tai & C.T. Wei).

Erysiphe emend. is reserved exclusively for teleomorphs of *Oidium* with “pseudoidium-type” conidiophores (Braun 1999, Braun *et al.* 2002). *O. moluccanum* is certainly an anamorphic *Erysiphe*, belonging to the subgenus *Pseudoidium*. Moreover, the surface patterns of wrinkled conidia of *O. moluccanum* examined under the SEM (Fig. 22) were angular to rectangular, which is a feature of the subgenus *Pseudoidium* (Cook *et al.* 1997, Braun *et al.* 2002).

Table 1 - Hosts and morphological characters of *Oidium moluccanum* and described anamorphs of *Erysiphe* spp¹ on *Euphorbiaceae*

Fungal species ²	Host	Mycelial appressoria	Conidiophore	Foot-cells	Conidia ⁴
<i>O. moluccanum</i>	<i>Aleurites moluccanus</i>	multilobed	26-192 x 4-10 μ m, 0-2(-4) septate	straight or flexuous, 26-46 x 4-10 μ m, sometimes swollen (up to 20 μ m wide)	22-50 x 12-22 μ m
<i>E. acalyphae</i>	<i>Acalypha</i> spp.	n.d. ³	long and slender, 0-3 septate	46-114 (-243) x 4-7 μ m, 4-6 times as long as the other cells	16-30 x 9-16 μ m;
<i>E. andina</i>	<i>Euphorbia</i> spp.	nipple-shape	n.d.	n.d.	25-34 x 12-18 μ m (dried)
<i>E. malloiti</i>	<i>Mallotus</i> spp.	n.d.	50-135 x 7-10 μ m, 1-2 septate, erect.	n.d.	27-53 x 16-24 μ m
<i>E. jatrophae</i>	<i>Jatropha</i> spp. and <i>Acalypha angustata</i> Sond.	n.d.	n.d.	n.d.	30-40 x 15-20 μ m
<i>E. euphorbiicola</i>	<i>Euphorbia</i> spp. and <i>Manihot esculenta</i> Crantz	nipple-shape to lobed	2 septate, straight, erect.	cylindric, 19-33 x 7.5-10 μ m	24-35 x 13-19 μ m
<i>E. securinegae</i>	<i>Securinega suffruticosa</i> (Pall.) Rehd.	n.d.	42-61 x 7-11 μ m, 0-2 septate, erect.	cylindric or somewhat curved to flexuous	19-36 x 9-17 μ m

¹ According to Braun (1987).² All *Erysiphe* spp. have amphigenous mycelia, whereas *O. moluccanum* has hypophyllous mycelium and sometimes hyphal swellings.³ n.d. = not described.⁴ There is no information about germ tubes.

The anamorphs of *E. alchorneae*, *E. aleuritis*, *E. bischoffiae*, *E. euphorbiacearum*, *E. euphorbiae*, and *E. phyllanthi* were not described. *Oidium moluccanum* differs from the other six species (*E. acalyphae*, *E. andina*, *E. euphorbiicola*, *E. jatrophae*, *E. malloiti*, and *E. securinegae*) in the shape of the conidiophore. It has short to very long conidiophores, either straight and cylindric (Figs 1–2) or geniculate (Figs 3–11), with a variable foot-cell. Sometimes, the cell above the foot-cell is also flexuous or bent (Figs 8–11). If a swollen conidiophore or hyphal cell becomes detached, it may be mistaken for a conidium (Figs 16–21). Other differences between *O. moluccanum* and these six species of *Erysiphe* are shown in Table 1. There are many trichomes on the abaxial leaf surface of *Aleurites molucannus* that might influence the shape of the conidiophores.

E. aleuritis is the only other powdery mildew described from *Aleurites*. Wei (1942) stated that its anamorph had amphigenous mycelium and did not describe the anamorph further. According to Braun (1987), this species is only known from the type collection, which is not preserved.

Acknowledgements

The authors thank Dr M. Havrylenko, Universidad Nacional del Comahue, Argentina, and Dr U. Braun, Martin-Luther-Universität, Germany, who kindly reviewed the manuscript. The authors acknowledge Mr Americo Brito (Crop Protection Division, Ministry of Agriculture and Fisheries, East Timor), The University of Queensland for the use of SEM facilities and Mrs Desley Tree (BRIP) is thanked for her assistance with the SEM. J. R. Liberato acknowledges financial support from the Brazilian Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Literature Cited

- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). Beih. Nova Hedwigia 89: 1–700.
- Braun U. 1999. Some critical notes on the classification and the generic concept of the *Erysiphaceae*. Schlechtendalia 3: 48–54.
- Braun U, Cook RTA, Inman AJ, Shin, H-D. 2002. The taxonomy of the powdery mildew fungi. In Bélanger RR., Bushnell WR, Dik AJ, Carver, TLW. eds. The powdery mildews: a comprehensive treatise. St. Paul, MN, APS Press. pp.: 13–55.
- Cook RTA, Inman AJ, Billings C. 1997. Identification and classification of powdery mildew anamorphs using light and scanning electron microscopy and host range data. Mycol. Res. 101: 975–1002.
- Mabberley DJ. 1998. The Plant-Book. Cambridge University Press.
- Wei CT. 1942. Notes on Chinese fungi X. *Erysiphaceae* of Western Szechwan. Nanking Journal 11(3): 103–116.

A new species of *Acrogenospora* from submerged Bamboo in Yunnan, China

HONG ZHU¹, LEI CAI²,
KEVIN D. HYDE² & KEQIN ZHANG^{1,*}

* kqzhang1@yahoo.com.cn

¹Laboratory for Conservation and Utilization of Bio-resource, Yunnan University
Kunming, Yunnan, 650091, China

²Centre for Research in Fungal Diversity, Department of Ecology & Biodiversity
The University of Hong Kong, Pokfulam Road, Hong Kong SAR, China

Abstract — *Acrogenospora verrucospora* sp. nov., found on submerged wood collected in a stream in Tangchi, Yunnan, China, is described, illustrated and compared with similar taxa. It is unique in *Acrogenospora* in having conidia with verrucose walls.

Key words — anamorphic fungi, freshwater fungi, lignicolous fungi, taxonomy

Acrogenospora was established by Ellis (1971) to accommodate the single species *A. sphaerocephala* (Berk. & Broome) M.B. Ellis. The genus is characterized by acrogenous, 1-celled conidia produced from mononematous, unbranched conidiophores that undergo percurrent proliferation. Goh et al. (1998) reviewed the genus and provided a key to the eight accepted species. *Acrogenospora* species are commonly found on dead wood in terrestrial or in freshwater habitats (Goh et al. 1998, Cai et al. 2003a, Tsui & Hyde 2004, Fryar et al. 2004). Two species are known to have a teleomorph: *A. altissima* (Gold.) and *A. megalospora* (Berk. & Broome) link to *Farlowiella australis* Dennis (Ellis, 1972) and *F. carmichaeliana* (Berk.) Sacc. (Goh et al. 1998), respectively.

In a continuing study of freshwater fungi in Yunnan, China (Cai et al. 2002, 2003b, Luo et al. 2004), a previously undescribed species of *Acrogenospora* was collected. This fungus is distinct from other *Acrogenospora* species in having verrucose conidia, and is described in this paper as a new species.

Materials and Methods

Submerged bamboo culms were collected from a forest stream in Tangchi, Yunnan, China, and returned to the laboratory in zip lock plastic bags. Samples were processed and examined following the methods described in Cai et al. (2002). The type specimen is deposited in HKU(M).

Taxonomy

Acrogenospora verrucospora Hong Zhu, L. Cai & K.Q. Zhang, **sp. nov.**

FIGURES 1-12

Coloniae effusae, atrae, nitidae, pilosae. *Mycelium* plerumque immersum, ex hyphis septatis, laevibus, tenuitunicatis, subhyalinis vel pallide brunneis compositum. *Conidiophora* macronemata, mononemata, $100\text{--}230 \times 5\text{--}6 \mu\text{m}$, solitaria vel 2-4 aggregata, erecta, septata, non-romosa, recta vel leniter flexuosa, cylindrica, brunnea vel atro-brunnea, apicem versus pallidiora. *Cellulae conidiogenae* monoblasticae, integratae, terminales, cylindrica, pallide brunneis, proliferationes conidiogenas percurrentes elongescentia. *Conidia* acrogena, holoblastica, solitaria, sicca, simplicia, sphaerica vel subsphaerica, 0-septata, $19\text{--}21.5 \mu\text{m}$ diametro ($\bar{x} = 20.2 \mu\text{m}$, $n = 30$), modice vel atro-brunnea, crassitunicata, verrucosa. Conidiorum secessio schizolytica.

Colonies effuse, black, glistening, hairy. *Mycelium* mostly immersed, consisting of septate, smooth, thin-walled, subhyaline to pale brown hyphae. *Conidiophores* macronematous, mononematous, $100\text{--}230 \times 5\text{--}6 \mu\text{m}$, solitary or in groups of 2-4, erect, septate, unbranched, straight or slightly flexuous, cylindrical, brown to dark brown, paler towards the apex. *Conidiogenous cells* monoblastic, integrated, terminal, cylindrical, pale brown, proliferating percurrently. *Conidia* acrogenous, holoblastic, solitary, dry, simple, spherical or subspherical, 0-septate, $19\text{--}21.5 \mu\text{m}$ diam. ($\bar{x} = 20.2 \mu\text{m}$, $n = 30$), mid to dark brown, thick-walled, verrucose. Conidial secession schizolytic.

Holotype here designated. – China, Yunnan, Tangchi, a small forest stream, on submerged bamboo culms, 6 April 2004, H. Zhu and J. Luo, HKU(M)17494.

Teleomorph. – Unknown.

Etymology. – *verrucospora*, referring to the verrucose conidia.

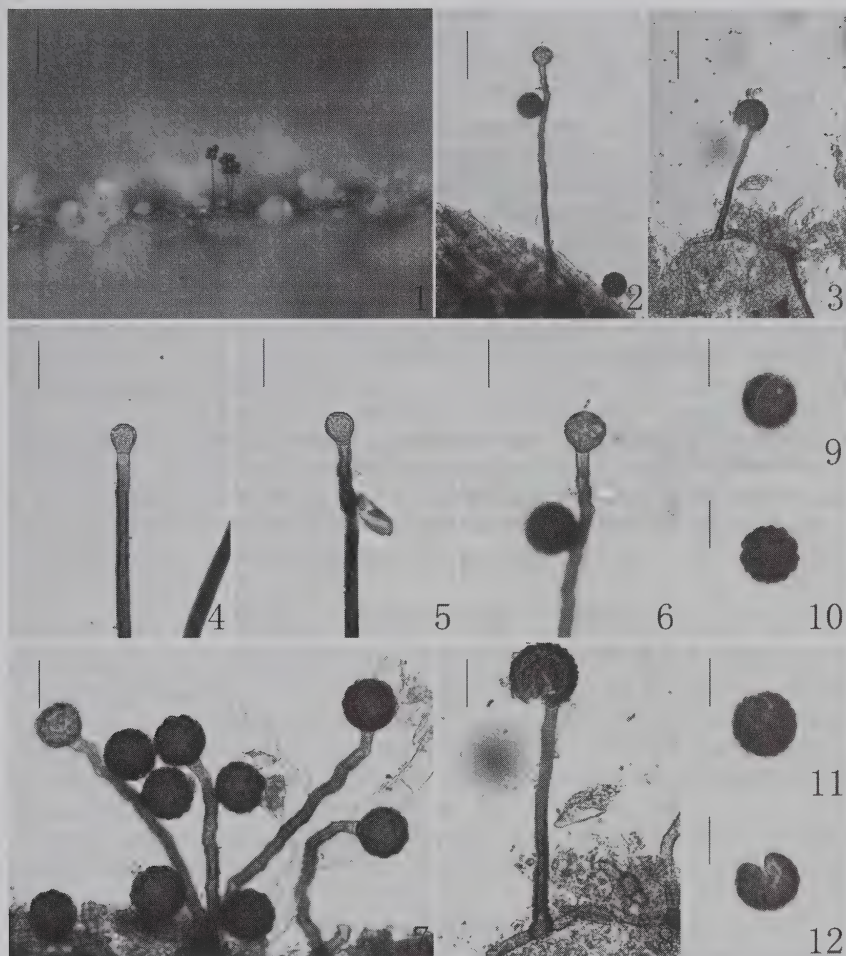
Habitat. – Saprobic on submerged bamboo culms.

Known distribution. – China.

Discussion

The conidiophores of *Acrogenospora verrucospora* are macronematous, mononematous, and percurrently proliferating, while the conidia are acrogenous, solitary, and non-septate. These characters are identical with the generic concept of *Acrogenospora* (Ellis, 1971). The genus *Domingoella* is similar, but *Domingoella* species have conidia with a protuberant peg at the base. *Acroditys* is also similar, but this genus includes species producing muriform conidia.

Acrogenospora verrucospora is most comparable to *A. sphaerocephala*, which also has spherical to subspherical conidia. However, the conidia of *A. sphaerocephala* are smooth and larger, $15\text{--}33 \times 14\text{--}33$ (28×27) μm . Other species in the genus have obovoid or ellipsoidal conidia. *A. verrucospora* is the only species in the genus that is known to produce verrucose conidia.



Figs 1-12. *Acrogenospora verrucospora*, holotype. **1.** Colonies on substrate. **2-8.** Conidiophores with developing conidia. Note that in fig 2 and fig 6 the mature conidium is pushed sideways following successive percurrent proliferation of the conidiophore. **9-12.** Mature conidia with verrucose walls. Scale bars: 1 = 200 μm ; 2, 3 = 40 μm ; 4-12 = 20 μm .

Acknowledgements

This study was funded by 973 Program (No. 2003CB415102) and the International Cooperation Research Foundation, Yunnan Province (2000C002). Dr. Eric H.C. McKenzie and Prof. D.J. Bhat are thanked for pre-submission review of this paper. J. Luo is thanked for facilitating the collecting trips. Hong Zhu would like to thank Y. Li for her kind help. Lei Cai thanks the University of Hong Kong for providing a postgraduate studentship.

References

- Cai L, Tsui KM., Zhang KQ, Hyde KD. 2002. Aquatic fungi from Lake Fuxian, Yunnan, China. *Fungal Diversity* 9: 57-70.
- Cai L, Zhang KQ, McKenzie EHC, Hyde KD. 2003a. Freshwater fungi from bamboo and wood submerged in the Liput River in the Philippines. *Fungal Diversity* 13: 1-12.
- Cai L, Zhang KQ, McKenzie EHC, Hyde KD. 2003b. New species of *Dictyosporium* and *Digitodesmium* from submerged wood in Yunnan, China. *Sydowia* 55: 129-135.
- Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute: Kew, Surrey.
- Ellis MB. 1972. Dematiaceous Hyphomycetes. XI. *Mycological Papers* 131, 1-25.
- Fryar SC, Booth W, Davies J, Hodgkiss IJ, Hyde, KD. 2004. Distribution of fungi on wood in the Tutong River, Brunei. *Fungal Diversity* 17: 17-38.
- Goh TK, Hyde KD, Tsui KM. 1998. The hyphomycete genus *Acrogenospora*, with two new species and two new combinations. *Mycological Research* 102: 1309-1315.
- Luo J, Yin JF, Cai L, Zhang KQ, Hyde KD. 2004. Freshwater fungi in Lake Dianchi, a heavily polluted lake in Yunnan, China. *Fungal Diversity* 16: 93-112.
- Tsui CKM, Hyde KD. 2004. Biodiversity of fungi on submerged wood in a stream and estuary in the Tai Ho Bay, Hong Kong. *Fungal Diversity* 15: 205-220.

MYCOTAXON

Volume 92, pp. 387–394

April–June 2005

Some trans-septate species of the genera *Hemithecium* and *Platythecium* from India

BHARATI ADAWADKAR & URMILA MAKHIJA

UV_Makhija@hotmail.com

Agharkar Research Institute, G.G. Agarkar Road
Pune - 411 004, India

Abstract— Three new species of *Hemithecium*, namely *H. balaghattensis*, *H. fulvescens*, *H. staigeriae*, and three new species of *Platythecium*, namely *P. commiscens*, *P. occultum* and *P. verrucoareolatum* in the family *Graphidaceae* have been recorded from India. A new combination, *Hemithecium nagalandicum*, is proposed.

Keywords— lichenized ascomycetes, taxonomy

Introduction

In a previous paper (Makhija & Adawadkar 2005) we have described five species belonging to *Hemithecium* Trevis. and *Platythecium* Staiger in the family *Graphidaceae*, namely *H. aphaneomicrosporium* Makhija & Adawadkar, *H. croceum* Makhija & Adawadkar, *H. pulchellum* Makhija & Adawadkar, *H. scariosum* Makhija & Adawadkar, and *Platythecium parvicarpum* Makhija & Adawadkar from the Andaman and Nicobar Islands of India. As a result of our continuing study of the lichen family *Graphidaceae* in India, we have discovered further four species in the genus *Hemithecium* and three species in the genus *Platythecium* which are described below.

Materials and Methods

Secondary products were identified by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970; Culberson 1972; White & James 1985) with the solvent systems benzene-dioxane-acetic acid (180:45:5), toluene-ethylacetate-formic acid (139:83:8) and toluene-acetic acid (200:30). All specimens were examined under UV light (365 nm).

Key to the species

1a. Excipular labia well developed.

Exciple non carbonised, convergent *Hemithecium* 2

1b. Excipular labia poorly developed.

Exciple divergent, carbonisation restricted to the base, lateral exciple only poorly developed forming a narrow brownish layer *Platythecium* 5

2a. Ascospores more than 100 μm long.

Thallus gray, smooth to uneven; ascomata large, 6–15 mm long, concolorous with the thallus; exciple with verrucose margin, heavily crenate, present below; ascospores (45-) 52–122 x 8–12 μm in size; constictic, norstictic and stictic acids present *H. nagalandicum*

2b. Ascospores less than 100 μm long 3**3a. Ascomata more than 5 mm long; protocetraric acid present.**

Thallus dull yellow; ascomata 0.5–6 mm long, simple to branched, immersed; ascospores 9–12-trans-septate, 29–42 x 4–6 μm ; protocetraric, stictic and constictic acids present *H. fulvescens*

3b. Ascomata short, up to 3 mm long; protocetraric acid absent 4

4a. Thallus greenish gray; ascomata 0.2–2.0 mm long, simple, triradiate or irregularly branched, pale brown, immersed; disc pruinose; exciple entire, present below; ascospores 10–14-trans-septate, 33–42 (-46) x 6–8 μm ; norstictic and stictic acid presents *H. balaghattensis*

4b. Thallus white with greenish tinge, distinctly warty, farinaceous; ascomata 0.5–3.0 mm long, simple to branched, concolorous, scattered all over, immersed, acute ends; exciple present at the base, entire, internal striae, orange brown; ascospores 5–7-trans-septate, 21–29 x 4–5 μm in size; consalazinic acid, testacein A and testacein B present *H. staigeriae*

5a. Norstictic acid present

Thallus white or buff, verrucose, areolate; ascomata small, 0.2–0.4 mm long, concolorous, in scattered groups, immersed; ascospores 5–7-trans-septate, 12–25 x 3–4 μm ; UV+, lichexanthone, consalazinic, hypostictic and norstictic acids present *P. verrucoareolatum*

5b. Norstictic acid absent 6

6a. Thallus greenish white, irregularly warty; ascomata immersed, crowded, intermingled, crowded, profusely branched; ascospores 3–5-trans-septate, 12–25 x 4–8 μm ; UV+ yellow, lichexanthone, consalazinic acid present *P. commiscens*

6b. Thallus grayish white, smooth; ascomata minute, not visible with naked eyes, concolorous, flush with the thallus, with cherry red to black disc, simple to branched, immersed, acute ends; ascospores 5–7-trans-septate, 21–29 x 4–8 μm ; UV+; lichexanthone, consalazinic acid present *P. occultum*

Taxonomic descriptions

Hemithecium balaghattensis Adawadkar & Makhija, sp. nov.

Figure 1

Similis *Hemithecium oshioi* (M. Nakan.) M. Nakan. & Kashiwad., sed ascosporis majoribus differt.

Etymology: from the latin *ensis*, a place of origin, and Balaghat, the type locality.

Holotype here designated—India, Madhya Pradesh, Balaghat district, Chahili, 22 km from Lanji, 26.9.1986, *P.G. Patwardhan & P.K. Sethy*, 86.614; holotype: AMH.

Thallus greenish gray, cracked to form squarish areoles, unevenly thickened. **Ascomata** lirelline, pale brown, 0.2–2 mm long, simple, triradiate or irregularly branched, scattered, immersed, terminally acute to obtuse. **Disc** broad, black, pruinose. **Exciple** well developed, entire, non carbonised, orange brown, present at the base, convergent, covered by a thalline exciple to the top. **Epithecium** thin, hyaline. **Hymenium** hyaline, clear, 90–130 μm high and 155–160 μm broad, I-, KI-. **Hypothecium** thin, hyaline. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate. **Ascospores** 10–14-trans-septate, ellipsoidal, 33–46 x 6–8 μm , I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P+ orange; UV-; norstictic and stictic acids present.

Remarks—The new species *Hemithecium balaghattensis* resembles the Japanese species *H. oshioi* (M. Nakan.) M. Nakan. & Kashiw., in its morphology and chemistry but the latter species has much smaller ascospores, 20–28 x 7 μm in length. (Nakanishi et al. 2003).

The new species is named after its collecting locality Balaghat in Madhya Pradesh of India and is the only species, in the family *Graphidaceae*, so far recorded from this region.

Hemithecium fulvescens Adawadkar & Makhija, sp. nov.

Figure 2

Similis *Hemithecium laubertianum* (Fée) Staiger, sed acida protocetraricum, norsticticum, sticticum et consticticum continens differt.

Etymology: from the latin *fulvus*, dull yellow, a reference to colour of thallus.

Holotype here designated—India, Karnataka, South Canara, Hogga, foot hill of Charmudi ghat, on Mangalore-Mudigere road, 30.1.1976, *C.R. Kulkarni*, 76.1174; holotype: AMH.

Thallus dull yellow, rough, cracked, unevenly thickened, delimited by thin black hypothallus. **Ascomata** lirelline, concolorous with the thallus, 0.5–6 mm long, simple to branched, scattered, immersed to slightly raised above, terminally acute or obtuse. **Disc** narrow to moderately broad, brown, epruinose. **Exciple** entire, non carbonised, present below, convergent, covered by a thalline exciple to the top. **Epithecium** indistinct, K-. **Hymenium** hyaline, clear, 96–134 μm high and 138–147 μm broad, I-, KI-. **Hypothecium** thin, hyaline to pale yellowish orange. **Paraphyses** simple, long. **Asci** 8 sporate. **Ascospores** 9–12-trans-septate, ellipsoidal, 29–42 x 4–6 μm , I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P+ orange; UV-; stictic, constictic and protocetraric acids present.

Remarks—The new species *Hemithecium fulvescens* is probably close to *H. laubertianum* (Fée) Staiger, in respect of the exciple characters and ascospore size.

However *Hemithecium fulvescens* has protocetraric, stictic, and constictic acids in contrast to *H. laubertianum* which has no lichen substances.

The species has been collected on road side trees in primary broad leaved rainforest existing in South Canara which retain a fine assemblage of epiphytic lignicolous and foliicolous lichens. A large number of species are endemic to this region.

Specimens examined—Karnataka: Sringeri, 2 km, Sringeri-Balehonur road, C.R. Kulkarni & P.G. Patwardhan, 74.3196; Hebri, Agumbe-Udipi road, C.R. Kulkarni & P.G. Patwardhan, 74.2957, 74.2958, 74.2959, 74.2961 (AMH).

***Hemithecium nagalandicum* (K.P. Singh & G.P. Sinha) Adawadkar & Makhija, comb. nov. Figure 3**

= *Graphis nagalandica* K.P. Singh & G.P. Sinha Lichen Flora of Nagaland p. 95, 1994.

Type—India, Nagaland State, Wokha district, Vonkshong peak, alt. 1500 m, 29.10.1984, G.P. Sinha N 744-holotype (ASSAM)!

Thallus gray, smooth to slightly uneven. **Ascomata** lirelline, concolorous, 6–15 mm long, 0.4–0.5 mm broad, simple to branched, curved, flexuous, semi emergent to distinctly emergent, terminally round to obtuse. **Disc** narrow, pale brown, epruinose. **Thalline margin** concolorous, thick, subverrucose. **Exciple** pale brown, heavily crenate, dentate outside with numerous projections, non carbonised, studded with crystals in between the incisions. **Epithecium** indistinct, hyaline. **Hymenium** hyaline, clear, 105–170 μm high and 150–160 μm broad, I-, K/I-. **Hypothecium** thin, hyaline. **Paraphyses** simple, thin, unbranched. **Asci** cylindrical, 4–8 sporate. **Ascospores** 10–25-trans-septate, (45) 52–122 x 8–12 μm , I+ blue.

Chemistry—Thallus K+ yellow, C-, KC-, P+ yellow; UV-; norstictic, constictic as minor and stictic acid as major component present in the thallus.

Remarks—*Hemithecium nagalandicum* can easily be distinguished by the very large, branched lirellae with thick, subverrucose margin; complete, non carbonised, hyaline to yellowish brown and heavily crenate exciple; large 52–122 x 8–12 μm ascospores and stictic and norstictic acids.

***Hemithecium staigeriae* Adawadkar & Makhija, sp. nov. Figure 4**

Inter omnia *Hemithecium*, species nova distincte acidum consalazincium, testacein A et testacein B continens.

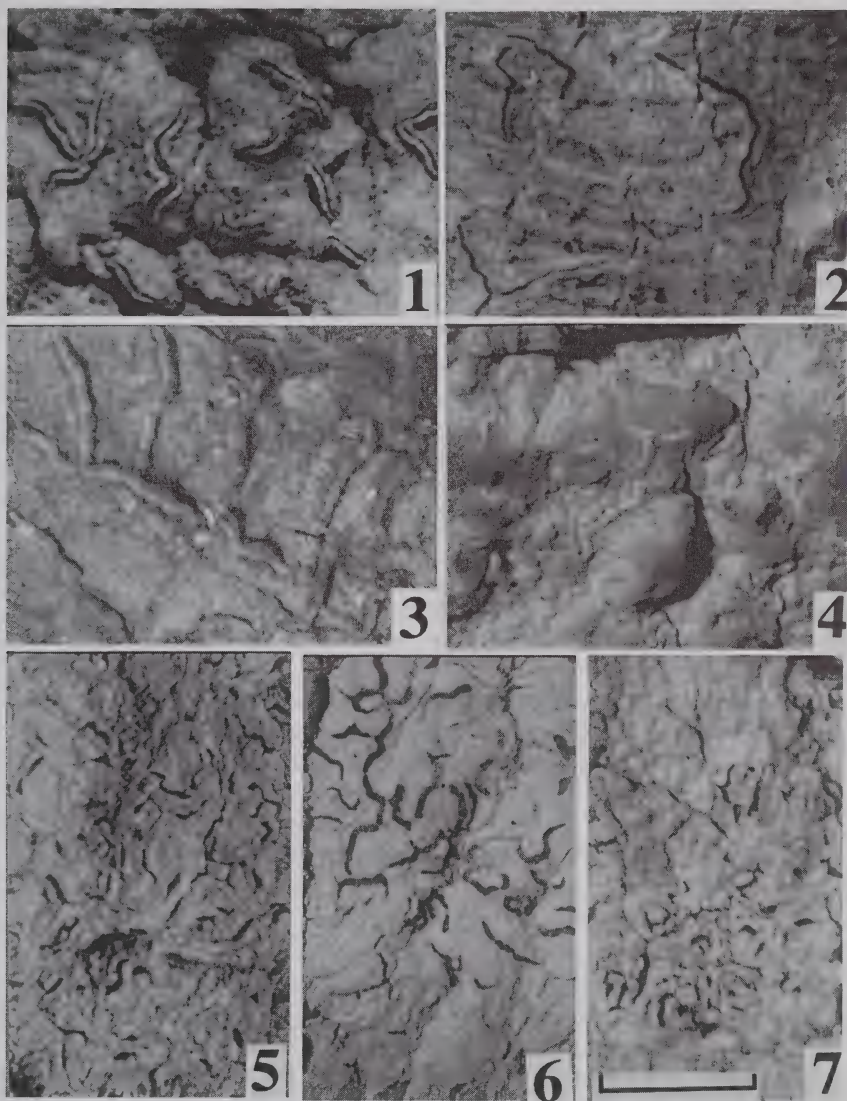
Etymology : in honor of the lichenologist Dr. Bettina Staiger.

Holotype here designated —India, Tamil Nadu, Kodaikanal, Silver Cascade, 26.1.1975, P.G. Patwardhan & A.V. Prabhu, 75.412; holotype: AMH.

Thallus white with greenish tinge, thick, cracked, unevenly thickened, farinaceous, delimited by thin black hypothallus. **Ascomata** lirelline, concolorous, 0.5–3 mm long, delicate, simple to branched, scattered, immersed, terminally acute to round. **Disc** narrow, reddish brown when wet, epruinose. **Exciple** complete, present below, convergent, slightly spreading at the apical region, covered by a thalline exciple to the top, entire or internally striate, non carbonised, orange brown. **Epithecium** thin, hyaline, K-. **Hymenium** hyaline, clear, 63–76 μm high and 63–71 μm broad, I-, KI-. **Hypothecium** thin, pale orange. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate. **Ascospores** 5–7-trans-septate, fusiform-ellipsoidal, 21–29 x 4–5 μm , I+ blue.

Chemistry—Thallus K+ yellow, C-, KC-, P+ orange; UV-; testacein A, testacein B and consalazinic acid present.

Specimens examined—Tamil Nadu: Kodaikanal, Silver Cascade, P.G. Patwardhan & A.V. Prabhu 75.405 (AMH); Kodai Lake, Dastoor Villa, P.G. Patwardhan 75.360 (AMH).



Figures—1-7. Habit (Holotypes) 1. *Hemithecium balaghattensis*; 2. *H. fulvescens* 3. *H. nagalandicum*; 4. *H. staigeriae*; 5. *Platythecium commiscens*. 6. *P. occultum*; 7. *P. verrucoareolatum*. Bar = 2 mm

Remarks—The new species *Hemithecium staigeriae*, is not comparable with any other known species of this genus; it is distinguished by its greenish white, farinaceous thallus, delicate, short (up to 3 mm long), concolorous, immersed ascomata; entire to sometimes internally striate exciple and the presence of testacein A, testacein B and consalazinic acid.

It has been collected in tropical montane forest.

***Platythecium commiscens* Adawadkar & Makhija, sp. nov.**

Figure 5

Similis *P. grammitis* (Fée) Staiger, sed lichexanthone continens differt.

Etymology: from the latin *commiscens*, intermingling, a reference to the intermingled lirellae.

Holotype here designated —India, Tamil Nadu, Kollaimalai, 15.10.1985, *M.B. Nagarkar & P.G. Patwardhan*, 85.1577; holotype: AMH.

Thallus whitish green to greenish, cracked, irregularly warty, delimited by a thin black hypothallus. **Ascomata** lirelline, short, flexuous, profusely branched, intermingled, crowded, completely immersed, terminally acute. **Disc** narrow, slit like, epruinose. **Exciple** entire, non carbonised, yellowish to woody brown, present at the base, convergent, covered by a thalline exciple to the top. **Epithecium** thin, hyaline. **Hymenium** hyaline, clear, 25–30 μm high and 60–70 μm broad, I-, KI-. **Hypothecium** orange yellow, studded with crystals. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate. **Ascospores** 3–5-trans-septate, ellipsoidal, 12–25 x 4–8 μm , I+ blue.

Chemistry—Thallus K-, C-, KC-, P-; UV+ yellow fluorescence; lichexanthone and consalazinic acid (in trace) present.

Remarks—The new species *Platythecium commiscens* is distinguished by the whitish green to greenish white, UV+ yellow thallus containing lichexanthone; immersed, profusely branched, concolorous, intermingled ascomata, and small ascospores of 12–25 x 4–8 μm .

The new species is somewhat similar to *Platythecium grammitis* (Fée) Staiger in its external morphology, but *P. grammitis* has always 3-trans-septate, smaller ascospores of 9–14 x 4–6 μm and has no lichen substances in its thallus.

The morphologically similar *Platythecium parvicarpum* Makhija & Adawadkar (Makhija & Adawadkar 2005), differs in lacking lichexanthone.

Specimen examined—**Tamil Nadu**: Chitteri, *P.G. Patwardhan & M.B. Nagarkar*, 83.32 (AMH).

***Platythecium occultum* Adawadkar & Makhija, sp. nov**

Figure 6

Similis *Platythecium allosporellum* (Nyl.) Staiger, sed acida consticticum, norsticticum et lichexanthone continens vice testacein differt.

Etymology: from the latin *occultans*, hidden, a reference to lirellae not visible with naked eye.

Holotype here designated —India, Tamil Nadu, Chitteri, 14.10.1985, *M.B. Nagarkar & P.G. Patwardhan*, 85.1446; holotype: AMH.

Thallus grayish white, smooth, cracked. **Ascomata** lirelline, concolorous with the thallus, 0.3–0.6 mm long, simple to branched, crowded and intermingled, immersed or flush with the thallus, terminally acute. **Disc** narrow to moderately broad, blackish brown when dry, dark cherry red when wet, epruinose. **Exciple** entire, non carbonised, orange yellow, present at the base, convergent to divergent, covered by a thalline exciple to the top. **Epithecium** thin, brown. **Hymenium** hyaline, clear, 40–45 μm high and

80–90 μm broad, I-. **Hypothecium** thin, yellowish. **Paraphyses** simple, long, thick, unbranched. **Asci** 6–8-sporate. **Ascospores** 5–7-trans-septate, ellipsoidal, 21–29 x 4–8 μm , I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P-; UV+ yellow fluorescence; lichexanthone, norstictic and constictic acids present.

Specimens examined—**Tamil Nadu**: Chitteri, *M.B. Nagarkar & P.G. Patwardhan*, 85.1372, 85.1415, 85.1416, 85.1425 (AMH).

Remarks—*Platythecium occultum* is characterised by a grayish white, UV+ thallus; minute, up to 0.6 mm long, immersed or flush with the thallus, concolorous, simple to radiately branched, ascomata; cherry red to blackish brown disc which is not visible with naked eye; entire, orange yellow exciple; 21–29 x 4–8 μm ascospores and by the presence of lichexanthone, constictic and norstictic acids.

Platythecium allosporellum (Nyl.) Staiger, which is similar in morphology, differs from the present species in not containing lichexanthone and has muriform ascospores of 9–15 x 5–8 μm .

Platythecium occultum appears to be most similar to the UV+, lichexanthone containing *Graphis anguinoides* ined. (Harris 1995), a species from Florida which differs in lacking consalazinic acid.

Platythecium verrucoareolatum Adawadkar & Makhija, **sp. nov.**

Figure 7

Similis *Platythecium occultum* sed thallo verrucoso et distincte areolato; acida hyposticticum et norsticticum continens differt.

Etymology: from the latin *areolatus*, areolate, marked out into small usually angular spaces, and *verrucosus*, warty, a reference to the warty and areolate thallus.

Holotype here designated—India, Tamil Nadu, Kollaimalai, 15.10.1985, *M.B. Nagarkar & P.G. Patwardhan*, 85.1500; holotype: AMH.

Thallus whitish or buff, verrucose, verruceae more or less globose, distinctly cracked and areolate. **Ascomata** lirelline, 0.2–0.4 mm long, in scattered groups, completely immersed, terminally acute to obtuse. **Disc** narrow, epruinose. **Exciple** entire, non carbonised, convergent, present below, covered by a thalline exciple to the top. **Epithecium** thin, brown. **Hymenium** hyaline, clear to sometimes interspersed with crystals, 50–60 μm high and 100–120 μm broad, I-, KI-. **Hypothecium** thin, hyaline. **Paraphyses** simple, long, thick, unbranched. **Asci** 8 sporate. **Ascospores** 5–7-trans-septate, ellipsoidal, 12–25 x 3–4 μm , I+ blue.

Chemistry—Thallus K+ red, C-, KC-, P-; UV+ yellow fluorescence, lichexanthone and consalazinic, hypostictic and norstictic acids present.

Remarks—*Platythecium verrucoareolatum* differs from the new species *Platythecium occultum* Adawadkar & Makhija (vide supra) in having a distinctly warty and areolate thallus, smaller ascomata scattered in groups and especially by its chemistry. The present new species has hypostictic, and norstictic acids in addition to the lichexanthone and consalazinic acids.

It has been collected in tropical montane forest at Kollaimalai in Eastern Ghats of India.

Acknowledgement

We are grateful to Dr. André Aptroot, CBS, Netherlands and Dr. A.W. Archer, National Herbarium of New South Wales, Australia, for valuable comments on the manuscript. We are also grateful to the Department of Science and Technology, Government of India, New Delhi, India for the financial support.

Literature Cited

- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. *J. Chromatogr.* **72**: 113-125.
- Culberson CF. & Kristinsson H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr.* **46**: 85-93.
- Makhija U, Adawadkar B. 2005. Some additions to the *Graphidaceae* in the Andaman islands, India. *Mycotaxon* **91**: 347-352.
- Nakanishi M, Kashiwadani H, Moon KH. 2003. Taxonomical notes on Japanese *Graphidaceae* (Ascomycotina), including some new combinations. *Bull. Natn. Sci. Mus. Tokyo ser. B.*, **29**(2): 83-93.
- Harris RC. 1995. More Florida lichens including the 10 C tour of the Pyrenolichens. Publ. By New York Botanical Garden, USA. Pp. 1-191.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *Bull. British Lichen Soc.* **57**:1-41 (Suppl.).

MYCOTAXON

Volume 92, pp. 395-416

April–June 2005

Additions and corrections to names published in *Cercospora* and *Passalora*

UWE BRAUN

uwe.braun@botanik.uni-halle.de

Martin-Luther-Universität, FB. Biologie, Institut für Geobotanik und Botanischer
Garten, Neuwerk 21, D-06099 Halle (Saale), Germany

PEDRO W. CROUS

crous@cbs.knaw.nl

Centraalbureau voor Schimmelcultures, Fungal Biodiversity Centre
P.O. Box 85167, NL-3508 AD Utrecht, The Netherlands

Abstract — The new species *Cercospora bothriochloae*, *C. phaseoli-lunati*, *C. smilacigena*, *Passalora brandenburgeri*, *Pseudocercospora lepidagathidis*, *P. sambucigena*, *P. xanthorhizae* and *Stenella hymenocallidis*, the new names *Pseudocercospora clematidigena*, *P. tinosporigena* and *Stenella deightoniana*, and the new combinations *Passalora cardiostegiae*, *P. lemnicheae*, *Pseudocercospora forestierae* and *P. garryae* are introduced. Additions and corrections to the nomenclature, taxonomy, typification, host range and distribution of fungi recorded in a checklist of *Cercospora* and *Passalora* names are also provided.

Key words — hyphomycetes, *Mycosphaerella* anamorphs, leaf spotting fungi

Introduction

Crous & Braun (2003) introduced a world checklist of names published in *Cercospora* Fresen. and *Passalora* Fr., containing data on the nomenclature, taxonomy, typification, host range and distribution of more than 5500 cercosporoid fungi. It is perhaps not surprising that a list of this size was later found to contain some errors and omissions. Also, new data soon appeared originating from new references or from the examination of additional herbarium specimens.

Since the publication of the checklist of *Cercospora* and *Passalora* names in 2003, numerous additional specimens from various herbaria, including some elusive type specimens, have been examined. A few new species, found among these specimens are described in the first few pages. Subsequent sections contain additions and corrections to data in Crous & Braun (2003). The species concerned are listed in alphabetical order, following the arrangement in the checklist. Accepted names are printed in bold. Typing errors without effect on the status of a name are not included.

**New species of *Cercospora*, *Passalora*,
Pseudocercospora and *Stenella***

***Cercospora bothriochloae* U. Braun & Crous, sp. nov.**

MB500170

Fig. 1

Differt a *C. echinochloae* conidiophoris 0–1-septatis, apicem versus pallidioribus, conidiis saepe 1–3-septatis.

Holotype here designated: on *Bothriochloa saccharoides* (Poaceae), USA, Kansas, Meade Co., near State Lake, 18 June 1957, C.T. Rogerson (NY).

Leaf spots amphigenous, oblong, striate, usually confined by veins, up to 20 mm long and 1–2 mm wide, brown, margin indefinite or occasionally with a narrow purplish violet border. Caespituli amphigenous, punctiform, brown. Mycelium internal. Stromata substomatal, 10–30 μ m diam, brown, composed of swollen hyphal cells, up to 9 μ m diam. Conidiophores in small to moderately large fascicles, loose to moderately dense, arising from stromata, emerging through stomata, erect, straight, subcylindrical to slightly geniculate-sinuuous, unbranched, 10–60 $\times$ 3–6 μ m, occasionally swollen at the base up to 10 μ m, 0–1-septate, subhyaline to pale olivaceous-brown, thin-walled, smooth; conidiogenous cells integrated, terminal or conidiophores reduced to conidiogenous cells, 10–40 μ m long; conidiogenous loci conspicuous, 1.5–2.5(–3) μ m wide, thickened and darkened. Conidia solitary, obclavate-subcylindrical, subfusiform, 15–45 $\times$ 3–4 μ m, (0–)1–3(–4)-septate, colorless, smooth, apex obtuse, base obconically truncate, 1.5–2 μ m wide, hila somewhat thickened and darkened.

Notes: *Cercospora bothriochloae* on *Bothriochloa saccharoides* (Poaceae, Andropogoneae) is morphologically quite distinct from the *C. apii* Fresen. complex, which is characterized by having long, usually acicular, pluriseptate, hyaline conidia. It belongs to a group of *Cercospora* species on grasses which is well-distinguished from *C. apii* s. lat. by possessing relatively short obclavate-cylindrical conidia with few septa. *Cercospora echinochloae* Davis on *Echinochloa* spp. (Poaceae, Paniceae; Chupp 1954; type material from WIS examined) is morphologically very close to *C. bothriochloae*, but easily distinguishable by having pluriseptate conidiophores, pigmented throughout, and 2–5-septate conidia. *Cercospora chusqueae* Chupp (Chupp 1954; type material, CUP 39412, examined), described from Colombia on *Chusquea* sp., has similar conidia, but the conidiophores are very long, 30–160 $\times$ 3–5.5 μ m, and pluriseptate.

***Cercospora phaseoli-lunati* U. Braun & Crous, sp. nov.**

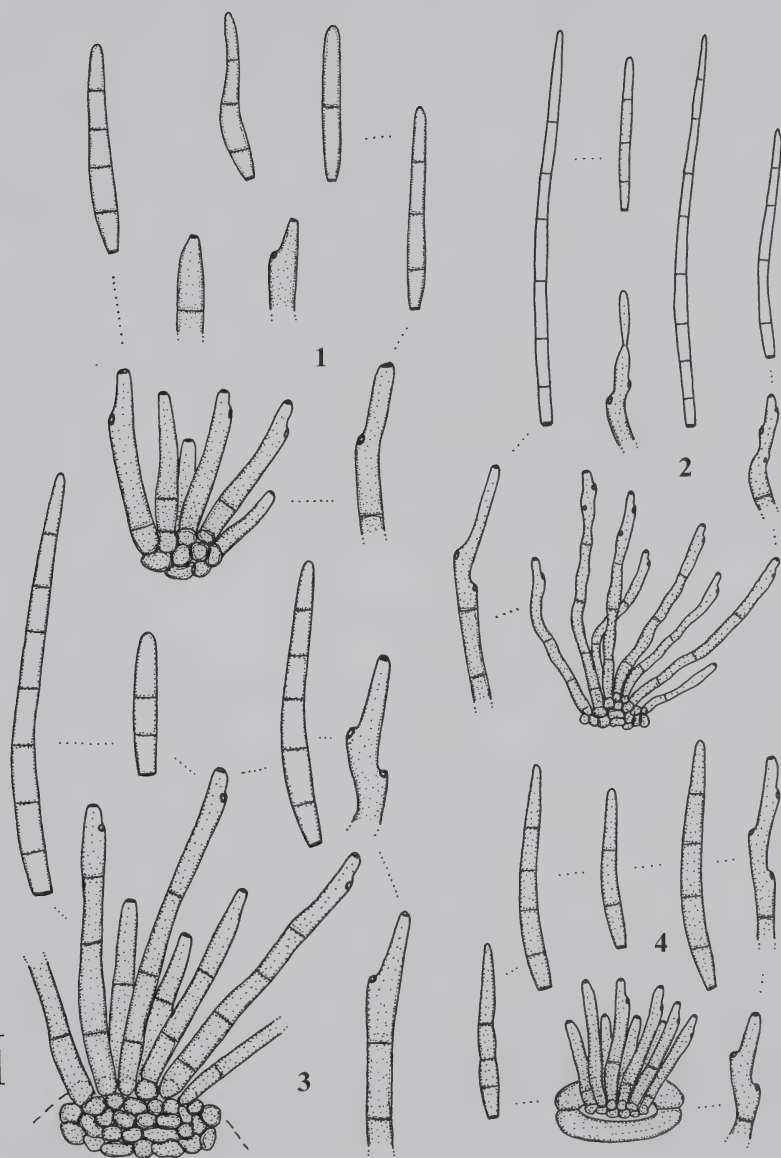
MB500171

Fig. 2

Differt a *C. apii* (incl. *C. canescens*, *C. caracallae*, *C. kikuchii*), *C. phaseolicola* et *C. phaseolina* locis conidiogeni minutis, 1–2 μ m diam, conidiis anguste acicularibus-filiformibus, (20–)30–100 $\times$ 1–3 μ m, pluriseptatis, hiliis 1–2 μ m latis.

Holotype here designated: on *Phaseolus lunatus* (Fabaceae), USA, Alabama, Tuskegee, 5 Jul. 1897, G.W. Carver, No. 290 (NY).

Leaf spots amphigenous, subcircular to angular-irregular, 1–5 mm wide, on the upper side brownish to grayish white, on the lower side greenish, grayish green to brownish, with a narrow to wide brown border. Caespituli amphigenous, mainly epiphyllous, scattered,



Figs 1–4. Fascicles of conidiophores, conidiophores, conidia. **1.** *Cercospora bothriochloae*. **2.** *Cercospora phaseoli-lunati*. **3.** *Cercospora smilacigena*. **4.** *Passalora brandenburgeri*. Scale bar = 10 μm .

punctiform, brown. Mycelium internal. Stromata intraepidermal to substomatal, 10–50 μm diam, brown. Conidiophores in small to moderately large fascicles, loose to dense, arising from stromata, through stomata or erumpent through the cuticle, erect, straight, subcylindrical-filiform to geniculate-sinuous, usually unbranched, 20–100 $\times$ 2.5–5(–6) μm , aseptate to usually pluriseptate, subhyaline, pale olivaceous to olivaceous-brown, tips usually paler, often subhyaline, thin-walled, smooth; conidiogenous cells integrated, terminal and intercalary, 10–40 μm long; conidiogenous loci conspicuous, thickened and darkened, 1–2 μm wide. Conidia solitary, acicular-filiform, (20–)30–100 $\times$ 1–3 μm , pluriseptate, hyaline, thin-walled, smooth, apex subacute, base truncate to somewhat obconically truncate, 1–2 μm wide, hila slightly thickened and darkened.

Notes: *Cercospora apii* s. lat. (incl. *C. canescens* Ellis & G. Martin, *C. caracallae* (Speg.) Vassiljevsky & Karak., *C. kikuchii* T. Matsumoto & Tomoy.), which is common on *Phaseolus* spp., differs from the new species in having much wider conidiogenous loci, (1.5–)2–3.5(–4.5) μm diam, and wider conidia, (10–)30–250(–380) $\times$ (1.5–)2–5(–5.5) μm , with wider hila, (1.5–)2–3(–4.5) μm (Crous & Braun 2003). *Cercospora phaseolicola* U. Braun & Mouch. (Braun et al. 1999), described on *Phaseolus* sp. from Vanuatu, is easily distinguishable by its long, non-geniculate conidiophores, 300–600 $\times$ 4–7 μm , wider conidiogenous loci, 2.5–3 μm diam, and longer and wider conidia, 50–200 $\times$ 3–5 μm . *Cercospora phaseolina* Speg. ('faseolina') is characterized by having short obclavate-cylindrical to fusiform conidia, 20–60 $\times$ 3–5 μm , with 1–5 septa (Braun 1994).

***Cercospora smilacigena* U. Braun & Crous, sp. nov.**

MB500172

Fig. 3

Differt a *C. apii* s. lat. stromatibus magnis, ad 150 μm diam, et conidiis obclavatis-cylindricis, 4–7 μm latis.

Holotype here designated: on *Smilax* sp. (*Smilacaceae*), Colombia, Bonda, 16 Nov. 1898, C.F. Baker, No. 98 (NY).

Leaf spots amphigenous, subcircular to irregular, 2–10 mm wide, center pale greenish-white, yellowish to ochraceous, later becoming dark due to abundant fructification, margin or halo narrow, darker, brownish, reddish, purple-violet, occasionally somewhat raised. Caespituli amphigenous, punctiform, dark brown, scattered to dense. Mycelium internal. Stromata substomatal to intraepidermal, erumpent, 10–150 μm diam, medium brown, composed of swollen hyphal cells, 2–8 μm diam. Conidiophores in small to mostly large fascicles, usually more or less loose, arising from stromata, erect, straight, subcylindrical to somewhat geniculate-sinuous, unbranched, 20–110 $\times$ 3–8 μm , pluriseptate, subhyaline to pale olivaceous or olivaceous-brown, smooth, wall thin to slightly thickened; conidiogenous cells integrated, terminal, occasionally intercalary, 10–60 μm long; conidiogenous loci conspicuous, thickened and darkened, 2–3 μm wide. Conidia solitary, obclavate-cylindrical, 25–100 $\times$ 4–7 μm , (1–)3–8(–12)-septate, colorless, smooth, thin-walled, apex obtuse, base truncate to obconically truncate, 2–3 μm wide, hila somewhat thickened and darkened.

Notes: *Cercospora smilacigena* differs from the whole *C. apii* s. lat. complex in having much broader, obclavate-cylindrical conidia. Several cercosporoid species have been described from *Smilax* spp., but all of them belong to *Passalora* and *Pseudocercospora*

[*Passalora smilacis* (Thüm.) U. Braun, *Pseudocercospora mississippiensis* (Tracy & Earle) R.F. Castañeda & U. Braun, *P. pallidissima* (Chupp) Deighton, *P. pycnidioides* (Chupp) U. Braun & Crous]. *Cercosporamiyakei* Henn. is an excluded, helminthosporioid species. *C. petersii* (Berk. & M.A. Curtis) G.F. Atk. has pigmented conidia and does not belong in *Cercospora* s. str. Type material of *C. petersii* could not be located, but it is possibly a member of *Passalora*.

***Passalora brandenburgeri* U. Braun & Crous, sp. nov.**

MB500173

Fig. 4

Etym.: Dedicated to Wolfgang Brandenburger (* 26 Oct. 1929, † 31 Jan. 2005), German phytopathologist and mycologist, who devoted his entire career to the research of plant-parasitic fungi.

Differt a *P. salicis* maculis evolutis, hyphis semper immersis, conidiophoris semper fasciculatis, locis conidiogeni 1–2 μm latis et conidiis solitariis, 3–6 μm latis.

Holotype here designated: on *Salix* sp. (*Salicaceae*), Egypt, El Harvaber, 15 Oct. 1928, L. Melchers, from "Mycol. Div., Egyptian Ministry of Agriculture" (NY).

Leaf spots amphigenous, 0.5–1.5 mm wide, subcircular to angular-irregular, dingy brown, grayish brown, later with grayish white center and darker margin, margin or even entire spots somewhat raised, occasionally with a diffuse, narrow halo, yellowish, brownish, reddish brown to dingy purplish violet. Caespituli amphigenous, punctiform, fine, dark brown. Mycelium internal. Stromata lacking or small, substomatal, 10–25 μm diam, olivaceous-brown. Conidiophores in small to moderately large fascicles, arising from internal hyphae or stromata, through stomata, erect, straight, subcylindrical to geniculate-sinuous, unbranched, 10–40 $\times$ (2–)3–5(–6) μm , 0–2-septate, pale to medium olivaceous-brown throughout or tips paler, walls thin to slightly thickened, smooth to faintly rough-walled; conidiogenous cells integrated, terminal or conidiophores occasionally reduced to conidiogenous cells, 10–30 μm long; conidiogenous loci conspicuous, slightly thickened and darkened, 1–2 μm wide. Conidia solitary, obclavate(-subcylindrical), (20–)25–65(–70) $\times$ 3–6 μm , (1–)3–4(–6)-septate, subhyaline, pale olivaceous to olivaceous-brown, smooth to faintly rough-walled, thin-walled, apex obtuse or subacute, base obconically truncate, 1.5–2 μm wide, hila slightly thickened and darkened.

Notes: There are various cercosporoid hyphomycetes on hosts of the *Salicaceae*, but *Passalora salicis* (Deighton, R.A.B. Verma & S.S. Prasad) U. Braun & Crous (= *Mycovellosiella salicis* Deighton, R.A.B. Verma & S.S. Prasad), known from China and India on *Salix tetrasperma* and *Salix* sp., is the only species belonging to *Passalora* emend. (Crous & Braun 2003). It differs from *P. brandenburgeri* in having superficial hyphae with solitary conidiophores, narrower conidiogenous loci, mostly 0.75–1 μm diam, and catenate, narrower conidia, 2.5–4.5 μm wide.

***Pseudocercospora lepidagathidis* U. Braun & Crous, sp. nov.**

MB500174

Fig. 5

Differt a *P. acanthi* stromatibus nullis et conidiophoris longioribus (ad 80 μm longis).

Holotype here designated: on *Lepidagathis alopecuroides* (*Acanthaceae*), Puerto Rico, San Juan, 10 Feb. 1962, H.L. Rubin 16490 (BPI 437637).

Leaf spots amphigenous, subcircular to somewhat irregular or almost diffuse, 1–5 mm wide, brownish, dingy olivaceous-brown to blackish brown or with a blackish purple tinge, margin indefinite. Caespituli hypophyllous, subeffuse, rather inconspicuous. Mycelium internal as well as external, superficial; hyphae emerging through stomata, sparingly branched, 1–3 μm wide, subhyaline to pale olivaceous or olivaceous-brown, thin-walled, smooth. Stromata lacking or only with very small substomatal hyphal aggregations. Conidiophores in small, usually loose fascicles, emerging through stomata, or solitary, arising from superficial hyphae, lateral or occasionally terminal, erect, straight to flexuous, geniculate-sinuous, unbranched or rarely branched, 5–80 $\times$ 2.5–5.5 μm , 0–4-septate, pale olivaceous-brown, thin-walled, smooth; conidigenous cells integrated, terminal or conidiophores reduced to conidigenous cells, 5–20 μm long; conidigenous loci inconspicuous, occasionally subdenticulate, but consistently unthickened and non-darkened. Conidia solitary, obclavate-cylindrical, 20–120 $\times$ 2–4 μm , 1–9-septate, subhyaline to pale olivaceous, thin-walled, smooth, apex obtuse to subacute, base obconically truncate, 1–2 μm wide, hila unthickened and non-darkened.

Notes: *Cercospora lepidagathidis* Govindu & Thirum. is the only cercosporoid hyphomycete described previously from a species of the genus *Lepidagathis*. Type material of this species could not be traced but, according to the original description, it has thickened and darkened conidigenous loci and colorless conidia which makes it a member of the genus *Cercospora* s. str. (Govindu & Thirumalachar 1955). Numerous species of the genus *Pseudocercospora* Speg. have been described from various hosts within the *Acanthaceae*. However, some of the species concerned are easily distinguishable by lacking superficial hyphae with solitary conidiophores, i.e., the conidiophores in these species are consistently fasciculate [*Pseudocercospora barleriae* (J.M. Yen & Lim) U. Braun, *P. blechi* U. Braun, Crous & N. Pons, *P. consociata* (G. Winter) Y.L. Guo & X.J. Liu, *P. rhinacanthi* (Höhn.) Deighton]. In *Pseudocercospora odontonematis* (Chupp) U. Braun & Crous and *P. thunbergiae* (Boedijn) U. Braun & Sivapalan, the conidiophores are uniformly short, 5–35 μm long, and only 0–2-septate. *Pseudocercospora baphicacanthi* Goh & W.H. Hsieh is characterized by having frequently branched conidiophores, usually non-fasciculate or only loosely grouped, up to 120 μm in length, in *P. justiciicola* P.N. Singh et al. leaf spots are lacking and the conidia are up to 119 μm long, with up to 14 septa, and are sometimes branched. *Pseudocercospora justiciae* (F.L. Tai) Y.L. Guo & X.J. Liu possesses longer and wider conidiophores, up to 130 $\times$ 4–6.5 μm , and much wider conidia, 3.5–6.5 μm (Chupp 1954, Crous & Braun 2003, Deighton 1987, Guo & Hsieh 1995, Hsieh & Goh 1990, Singh et al. 1996, Yen & Lim 1980).

***Pseudocercospora sambucigena* U. Braun, Crous & K. Schub., sp. nov.**
MB500175 **Fig. 6**

Differt a *P. ebulicola* maculis distinctis, stromatibus 10–40 μm diam, hyphis semper immersis, conidiophoris semper fasciculatis, non-ramosis, conidiis 4–6.5 μm latis.

Holotype here designated: on *Sambucus pubens* (*Caprifoliaceae*), USA, Pennsylvania, Dauphin Co., 21 Aug. 1921, O.E. Jennings, Acc. 6736 (NY).

Additional material examined: on *Sambucus nigra*, Italy, Parma, G. Passerini (B 70-6710), as *Cladosporium sambuci* Pass., in herb. (mixed infection together with *Cladosporium* sp.).

Leaf spots amphigenous, angular-irregular, 1–6 mm wide, grayish white, margin narrow, dark olivaceous-brown, dark purplish violet to blackish, or with a narrow purplish violet halo. Caespituli amphigenous, punctiform, dark brown, scattered. Mycelium internal. Stromata substomatal to intraepidermal, 10–45 μm diam, brown. Conidiophores in small to moderately large fascicles, loose to dense, arising from stromata, through stomata or erumpent through the cuticle, erect, straight, subcylindrical to somewhat flexuous, slightly geniculate-sinuous, unbranched, $30\text{--}150 \times 3\text{--}6 \mu\text{m}$, pluriseptate, occasionally constricted at the septa, pale olivaceous, olivaceous-brown to medium brown, paler towards the tips, wall thin to somewhat thickened, smooth; conidiogenous cells integrated, terminal, 10–30 μm long; conidiogenous loci inconspicuous. Conidia solitary, obclavate-subcylindrical, $30\text{--}110 \times 4\text{--}6.5 \mu\text{m}$, 2–8-septate, subhyaline to pale olivaceous, smooth, thin-walled, apex obtuse, base obconically truncate, $(1.5\text{--})2\text{--}(2.5) \mu\text{m}$ wide, hila unthickened, not darkened.

Notes: *Pseudocercospora ebulicola* (W. Yamam.) Deighton, the only species of *Pseudocercospora* on *Sambucus* spp., is easily distinguishable from *P. sambucigena* by having superficial hyphae with solitary conidiophores and narrower conidia.

Furthermore, the lesions are indistinct, true stromata are lacking and the conidiophores are frequently branched. The collection on *Sambucus nigra* from Italy agrees perfectly with the North American type specimen. It is a mixed collection of *Pseudocercospora sambucigena* and *Cladosporium* sp. with the *Pseudocercospora* predominating.

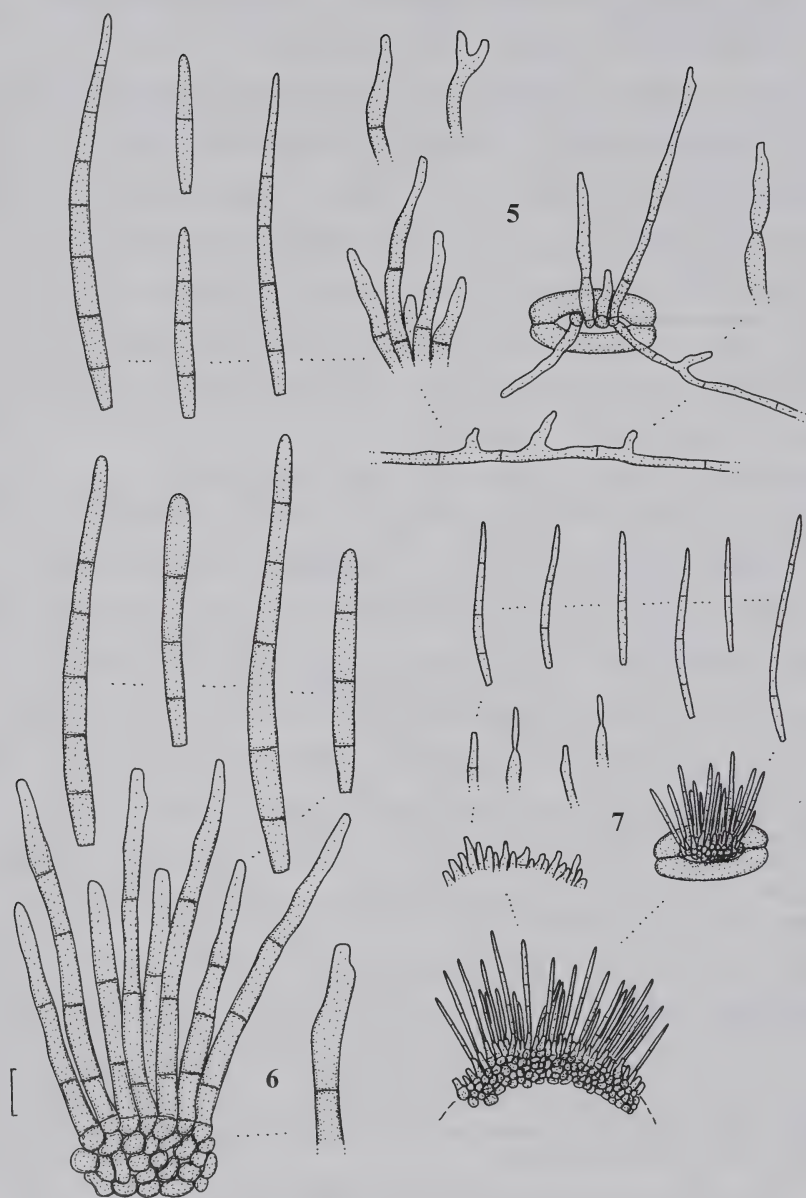
Pseudocercospora diervillae (Ellis & Everh.) U. Braun on *Diervilla* spp. in North America (Chupp 1954) is morphologically close to *P. sambucigena*, but the walls of the conidiophores are thickened and the conidia are wider, 5–7 μm , also with somewhat thickened walls. Other species of *Pseudocercospora* on hosts belonging to the *Caprifoliaceae* are distinct in having superficial hyphae with solitary conidiophores and narrower conidia, 2–4 μm wide (*Pseudocercospora lonicericola* (W. Yamam.) Deighton, on *Leycesteria* and *Lonicera* spp., and *P. weigeliae* (Ellis & Everh.) Deighton, on *Diervilla* spp. (= *Weigela*), non-sympodial, but percurrent conidiogenous cells (*Pseudocercospora viburnigena* U. Braun & Crous, = *Cercospora tineae* Sacc., on *Viburnum tinus*), short conidiophores, $5\text{--}25 \times 2\text{--}3.5 \mu\text{m}$, and narrower conidia, 2–4 μm wide (*P. lonicerae* (Chupp) U. Braun & Crous, on *Lonicera* spp.), dense, often coremioid conidiophore fascicles and narrower conidia, 2.5–4 μm wide (*Pseudocercospora viburni-cylindrici* (F.L. Tai) U. Braun = *P. khasiana* B.K. Gupta & Kamal, on *Viburnum* spp.) and well-developed stromata, up to 80 μm diam, shorter conidiophores, 10–70 μm in length, and almost consistently obclavate conidia (*Pseudocercospora varia* (Peck) J.K. Bai & M.Y. Cheng, on *Viburnum* spp.) (Chupp 1954, Hsieh & Goh 1990, Guo & Hsieh 1995, Crous & Braun 2003).

***Pseudocercospora xanthorhizae* U. Braun & Crous, sp. nov.**

MB500176

Fig. 7

Differt a *P. filiformis* stromatibus 10–70 μm diam, conidiophoris 1–2 μm latis et conidiis $10\text{--}50 \times 1\text{--}2 \mu\text{m}$, 0–3-septatis.



Figs 5–7. Fascicles of conidiophores, conidiophores, conidia, superficial hyphae with solitary conidiophores. **5.** *Pseudocercospora lepidagathidis*. **6.** *Pseudocercospora sambucigena*. **7.** *Pseudocercospora xanthorhizae*. Scale bar = 10 μm .

Holotype here designated: on *Xanthorhiza simplicissima* (Ranunculaceae), USA, Alabama, Lee Co., Auburn, 24 Apr. 1897, F.S. Earle & C.F. Baler (NY).

Leaf spots amphigenous, subcircular to angular-irregular, 1–6 mm wide, center at first grayish green, later straw-colored, brownish to grayish white, with a narrow, somewhat raised margin, brownish to dingy purplish brown, occasionally with an additional concolorous halo. Mycelium internal; hyphae sparingly branched, septate, 1–3 μm wide, subhyaline to pale olivaceous. Stromata 10–70 μm diam, substomatal, large stromata often widening and rupturing the stomata, somewhat erumpent, small stromata subhyaline to pale olivaceous, larger stromata yellowish brown, olivaceous-brown to somewhat reddish brown, composed of somewhat swollen hyphal cells, 1.5–4(–5) μm diam. Caespituli hypophyllous, punctiform, scattered, dark brown. Conidiophores in small to usually large fascicles, arising from stromata, forming sporodochial conidiomata, emerging through stomata, rarely erumpent, straight, subcylindrical, conic to slightly geniculate-sinuous, unbranched, 5–20 $\times$ 1–2 μm , aseptate, subhyaline to pale olivaceous, thin-walled, smooth, conidiophores reduced to conidiogenous cells; conidiogenous loci inconspicuous. Conidia solitary, persistently adhering to the conidiogenous cells, narrowly obclavate-cylindrical, fusiform, subacicular, short, 10–50 $\times$ 1–2 μm , inconspicuously 0–3-septate, hyaline, subhyaline to very pale olivaceous, thin-walled, smooth, apex subacute or subobtuse, base truncate to short obconically truncate, 1–2 μm wide, hila unthickened, not darkened.

Notes: The new species is somewhat intermediate between *Pseudocercospora* Speg. and *Pseudocercospora* Deighton. The conidiophores and conidia are only subhyaline to very pale olivaceous. Since the stromata are distinctly pigmented and the conidiophores are not quite colorless, we prefer to place it in the genus *Pseudocercospora*, in which it is a typical *Cercoseptoria*-like species due to well-developed sporodochial conidiomata with short one-celled conidiophores. *Pseudocercospora xanthorhizae* is morphologically close to *P. filiformis* (Davis) J.K. Bai & M.Y. Chen, known from *Anemone* and *Pulsatilla* species in China and North America (Chupp 1954, Guo & Hsieh 1995, Crous & Braun 2003), but the latter species is easily distinguishable by its larger stromata, up to 125 μm diam, wider conidiophores, 2–4 μm , and multiseptate conidia, 30–80 $\times$ 2–4 μm . Among *Pseudocercospora* species on hosts of the Ranunculaceae, *Pseudocercospora thalictricola* (Vassilevsky) U. Braun on *Thalictrum* species in North America (Braun 1995) resembles *Pseudocercospora xanthorhizae*, but differs in having colorless conidiophores and longer and somewhat wider conidia, 25–80 $\times$ 1.5–2.5 μm . Furthermore, the stromata are consistently intraepidermal.

***Stenella hymenocallidis* U. Braun & Crous, sp. nov.**

MB500177

Fig. 8

Differt a *Stenellopsis liriopes* conidiis saepe subcylindraceis-filiformibus, subacicularibus, ad basim saepe truncatis.

Holotype here designated: On *Hymenocallis crassifolia* (Amaryllidaceae), USA, Louisiana, Point a la Hache, June 1886, A.B. Langlois, Ellis & Everh., North American Fungi 1767 (NY).

On living and senescing leaves, lesions diffuse, shape and size variable, brown, reddish brown, without definite margin. Colonies amphigenous, punctiform, scattered, grayish

brown. Mycelium internal; hyphae septate, branched, 2–5 μm wide, subhyaline, smooth, thin-walled. Stromata substomatal, 10–50 μm diam, brown, composed of swollen hyphal cells, 2–7 μm diam, walls somewhat thickened. Conidiophores in small to moderately large fascicles, loose to very dense, arising from stromata, through stomata, erect, straight, subcylindrical-conical, slightly geniculate-sinuous, unbranched, 5–30 $\times$ 3–5 μm , 0–2-septate, subhyaline to pale olivaceous-brown, thin-walled, smooth or almost so; conidiogenous cells integrated, terminal or conidiophores reduced to conidiogenous cells, 10–20 μm long; conidiogenous loci conspicuous, somewhat thickened and darkened, 1–2 μm wide. Conidia solitary, short conidia ellipsoid-ovoid to short cylindrical, with truncate or short obconically truncate base, long conidia cylindrical-filiform, subacicular, occasionally narrowly obclavate-cylindrical, with truncate base, (15–)20–110 $\times$ 2.5–4 μm , (0–)1–8-septate, without any constrictions at the septa, subhyaline, pale olivaceous, olivaceous-brown, occasionally pale brown, thin-walled, verruculose, apex obtuse to subacute, base truncate to very short obconically truncate in short conidia, truncate in longer conidia, 1.5–2 μm wide, hila slightly thickened and darkened.

Notes: The new species is *Stenellopsis*-like but, although it lacks an external mycelium, we prefer to place it in *Stenella* Syd. The taxonomic position of the genus *Stenellopsis* Huguenin is not yet clear. This genus is differentiated from *Stenella* Syd. by the absence of an external mycelium. The conidiophores are formed in fascicles, and solitary conidiophores arising from superficial hyphae are absent. It is uncertain if these differences are sufficient to maintain two distinct genera (Crous & Braun 2003). Although we do not yet have molecular data on *Stenellopsis* species, it is clear that the *Stenella* morphotype evolved several times within *Mycosphaerella* (Crous & Braun, unpubl. data). Furthermore, we are of the opinion that using the presence or absence of a superficial mycelium as the sole differentiating character is insufficient to separate anamorph genera in *Mycosphaerella*. For this reason, we have chosen to place *Stenellopsis*-like species in the genus *Stenella*. *S. hymenocallidis* is the first member of the genus *Stenella* to be found on a plant belonging to the *Amaryllidaceae*. Although no *Stenella* species are presently known to occur on plants in the allied families Iridaceae and Liliaceae *s. lat.*, *S. hymenocallidis* is morphologically close to *Stenellopsis liriopes* (F.L. Tai) H.D. Shin & U. Braun [= *Cercospora liriopes* F.L. Tai, *Passalora liriopes* (F.L. Tai) Y.L. Guo (Chupp 1954, Shin & Braun 2000, Guo 2001)] on *Liriope platyphylla*, belonging to the allied family Liliaceae *s. lat.* (*Convallariaceae*). It differs, however, in having distinctly obclavate-cylindrical conidia, usually with obconically truncate bases.

Addition to the nomenclature of the genus *Stenella*

Stenella deightoniana U. Braun, **nom. nov.** MB500178

= *Cladosporium cercestidis* Deighton, Mycol. Res. 94: 570. 1990.

= *Stenella cercestidis* (Deighton) U. Braun, Schlechtendalia 5: 54. 2000, *nom. illeg.*, non *Stenella cercestidis* (J.M. Yen & Gilles) Deighton, 1979.

Notes: Braun (2000) introduced the new combination *Stenella cercestidis* (Deighton) U. Braun, based on *Cladosporium cercestidis*, which is, however, homonymous with *Stenella cercestidis* (J.M. Yen & Gilles) Deighton.

A second record of *Pseudocercospora violae*

Pseudocercospora violae Deighton, Trans. Brit. Mycol. Soc. 88(3): 374. 1987. Fig. 9

Material examined: on *Viola pedata*, USA, Alabama, Lee Co., Auburn, 18 Sept. 1897, F.S. Earle (NY), as *Cercospora* sp.

Leaf spots amphigenous, subcircular to somewhat angular-irregular, 2–6 mm wide, brown, margin indefinite. Caespituli amphigenous, punctiform, scattered to dense, dark dingy gray to dark grayish brown. Mycelium internal, hyphae sparingly branched, septate, 1.5–3.5 μm wide, smooth, subhyaline to pale olivaceous. Stromata lacking to well-developed, 10–60 μm diam, substomatal, occasionally intraepidermal, olivaceous-brown, composed of somewhat swollen hyphal cells, 2.5–8 μm diam. Conidiophores in small to large fascicles, loose to dense, arising from immersed hyphae or stromata, emerging through stomata, occasionally erumpent, erect, straight, subcylindrical-conical to geniculate-sinuous, unbranched, 5–25 $\times$ 2–5 μm , 0–1-septate, pale olivaceous, smooth, thin-walled; conidiophores mostly reduced to conidiogenous cells, conidiogenous loci inconspicuous or somewhat subdentate, 1–2 μm wide, but wall of the loci always unthickened and non-pigmented. Conidia solitary, obclavate, subcylindrical (-subacicular), (15–)25–75(–80) $\times$ 3–4 μm , (0–)1–7-septate, subhyaline to pale olivaceous, thin-walled, smooth, apex subacute or subobtuse, base obconically truncate, rarely truncate, (1–)1.5–2(–2.5) μm wide, hila unthickened, non-pigmented.

Notes: This species was described from Sierra Leone in Africa on *Viola* sp. (cultivated species). The North American collection on the native hosts species *Viola pedata* represents the second record for this species.

Additions and corrections to the list of names published in *Cercospora* and *Passalora*

The arrangement of the following enumeration agrees with the treatment in Crous & Braun (2003), with the exception that all epithets are alphabetically arranged together, irrespective of their location in the *Cercospora* and *Passalora* checklists. The following abbreviations are used: Lit. = literature (references), T = type.

abeliae* *Pseudocercospora (Katsuki) Nishijima, Nakashima & T. Kobay., Mycoscience 40: 269. 1999.

= *Cercospora abeliae* Katsuki, Ann. Phytopathol. Soc. Japan 20: 71. 1955.

= *Cercospora abeliae* Plakidas, Mycologia 48: 384. 1956, *nom. illeg.*, Art. 53 [T: BPI 422312, 422313; LSUM].

Hosts & Distribution: *Abelia chinensis*, *A. grandiflora*, *A. serrata*, *A. spathulata* (Caprifoliaceae), Japan, USA (FL, IL, LA).

Lit.: Katsuki (1965, p. 15).

Notes: Katsuki (1965) and Nishijima et al. (1999) cited *Cercospora abeliae* Plakidas as a synonym of *C. abeliae* Katsuki and *Pseudocercospora abeliae*, respectively, using the original description and illustration of this species as a basis. This synonymy is correct, and was confirmed by a re-examination of the American type material deposited at BPI.

acericola Passalora (X.J. Liu & Y.L. Guo) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 436. 2003.

≡ *Phaeoramularia acericola* X.J. Liu & Y.L. Guo, *Acta Phytopathol. Sinica* 12: 3. 1982.

≡ *Mycovellosiella acericola* (X.J. Liu & Y.L. Guo) Y.J. Liu & Y.L. Guo, *Mycosystema* 1: 242. 1988.

Add to host range and distribution: *Acer opalus*, *A. pseudoplatanus*, Germany, Italy.

Notes: Collections from Germany (on *Acer pseudoplatanus*, Germany, Bavaria, Freising, Aug. 2003, K.J. Lang, HAL) and Italy (on *Acer opalus* and *A. pseudoplatanus*, 'Foresta di Vallombrosa (Firenze)', 1896, Briosi et Cavara, *Funghi parassiti* 296, as '*Cercospora acerina*', HAL) proved to belong to this species. The conidiophores are fasciculate, occasionally solitary, arising from superficial hyphae; the conidiogenous loci are conspicuous, thickened and darkened, and the conidia are formed singly or occasionally catenate. *Passalora acericola* has previously been confused with *Cercospora acericola* Woron. (≡ *Pseudocercospora acericola* (Woron.) Y.L. Guo & X.J. Liu), which is, however, easily distinguishable by its inconspicuous, unthickened, non-pigmented conidiogenous loci.

adusta Cercospora Heald & F.A. Wolf, *Mycologia* 3: 14. 1911.

(= ***Cercospora apii* s. lat.**).

Additions to type material: BPI 432411, 432413.

apii Cercospora Fresen., *Beitr. Mykol.* 3: 91. 1863, s. lat. (incl. *C. canescens* Ellis & G. Martin).

Add to host range and distribution: *Crescentia cujete*, *Halimodendron halodendron*.

Material examined: on *Crescentia cujete*, USA, Alabama, Tuskegee, 12 Jul. 1897, G.W. Carver, No. 345 (NY). *Halimodendron halodendron*, USA, Kansas, State College, SW of Manhattan, Horticultural Farm, 17 Aug. 1955, C.T. Rogerson (NY).

austrinae Cercospora Chupp & Viégas, *Boletim Soc. Brasil. Agron* 8: 10. 1945.

(= ***Cercospora apii* s. lat.**).

Addition to type material: NY.

bidentis Cercospora Tharp, *Mycologia* 9: 108. 1917.

Addition to type material: NY.

bixae Pseudocercospora (Allesch. & F. Noack) Crous, Alfenas & R.W. Barreto, *Mycotaxon* 64: 418. 1997.

≡ *Cercospora bixae* Allesch. & F. Noack, *Bol. Inst. Agron. Estado São Paulo* 9: 85. 1898.

Add to type material: B.

bupleuri Passalora (Pass.) U. Braun, in Braun & Mel'nik, *Trudy Bot. Inst. Im. V.L. Komarova* 20: 44. 1997.

Add to host range and distribution: *Anthriscus cerefolium*, Germany.

Material examined: on *Anthriscus cerefolium*, Germany, Baden-Württemberg, Holzgerlingen, nursery, 11 Oct. 2004, K. Schrameyer (HAL).

capitati Cercospora Tharp, Mycologia 9: 108. 1917.

Addition to type material: NY (topotype, from 29 Oct. 1914).

cardiostegiae Passalora → *Passalora cardiostegiae* (B.H. Davis) U. Braun & Crous, **comb. nov.**

MB500183

Fig. 10

≡ *Cercospora cardiostegiae* B.H. Davis, Mycologia 32: 170. 1940 [T: BPI 434208].

Lit.: Chupp (1954, p. 589).

Notes: Type material of this species has been re-examined. It is a typical *Mycovellosiella*-like species of the genus *Passalora* with conidiophores in small fascicles emerging through stomata. Conidiophores may also arise singly from superficial hyphae that emerge through stomata. The conidiogenous loci are conspicuous, slightly thickened and darkened, 1.5–2 µm wide. The conidia are formed singly, obclavate-cylindrical, 15–60 × 4–7 µm, 1–4-septate, pale olivaceous to olivaceous-brown, with slightly thickened and darkened hila.

catalparum Passalora (Chupp) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 111. 2003.

Add to type material: NY.

clematidis Cercospora Boedijn, Nova Hedwigia 3(4): 426. 1961. [T: L 53850].

≡ *Pseudocercospora clematidigena* U. Braun & Crous, **nom. nov.** MB500184

(Replaced synonym: *Cercospora clematidis* Boedijn, Nova Hedwigia 3(4): 426. 1961, non *Pseudocercospora clematidis* Goh & W.H. Hsieh, 1989).

Misapplied names: *Pseudocercospora clematidis* Goh & W.H. Hsieh, auct. p.p. (e.g., Guo & Hsieh 1995, Braun 2001, Crous & Braun 2003) and *Pseudocercospora squalidula* (Peck) Y.L. Guo & X.J. Liu (Guo et al. 1998).

Notes: Cercosporoid hyphomycetes on *Clematis* species have previously been confused by most authors. Guo & Liu (in Fungi and Lichens of Shennongjian: 366, 1989) introduced the new combination '*Pseudocercospora squalidula*' and applied this name to the true *Pseudocercospora* on *Clematis* spp. in Asia. Later, Guo & Hsieh (1995) used the name *Pseudocercospora clematidis* Goh & W.H. Hsieh (Goh & Hsieh 1989) for this species and reduced *P. squalidula* to the status of a synonym. Later still, Guo et al. (1998) reintroduced the name *P. squalidula* for the fungus and cited *P. clematidis* as the synonym. Braun (in Braun & Mel'nik 1997) studied type material of *Cercospora squalidula* Peck and additional North American collections of this species and placed it in *Passalora*, based on the presence of thickened and darkened conidiogenous loci and hila. Braun (2001) re-examined type material of *Cercospora clematidis* Boedijn (1961) and reduced the latter name to synonymy with *Pseudocercospora clematidis*, based on the description of Goh & Hsieh (1990), indicating that the conidiophores are hyaline to pale olivaceous. Crous & Braun (2003) followed this treatment, which was, however, also based on a misinterpretation and misapplication. Recently, Kirschner et al. (2004) examined type material and additional new collections of *Pseudocercospora clematidis* from Taiwan, showed that the conidiophores and conidia are consistently colorless and reallocated this species to *Pseudocercospora* Deighton. Since a valid name for the Asiatic *Pseudocercospora* on *Clematis* is not available and the epithet '*clematidis*' is

preoccupied, we propose the introduction of the new name *P. clematidigena* for the fungus originally described by Boedijn (1961).

The three confusable cercosporoid fungi on *Clematis* spp. can be keyed out as follows:

1. Conidiophores and conidia consistently colorless; conidiogenous loci inconspicuous; superficial hyphae lacking. *Pseudocercospora clematidis* (Goh & W.H. Hsieh) Kirschner
- 1* Conidiophores and conidia pigmented, at least pale olivaceous 2
2. Conidiogenous loci conspicuous, somewhat thickened and darkened, 1.5–2 μ m wide; conidiophores fasciculate; superficial hyphae with solitary conidiophores lacking *Passalora squalidula* (Peck) U. Braun
- 2* Conidiogenous loci inconspicuous, neither thickened nor darkened; conidiophores fasciculate as well as solitary, arising from superficial hyphae. *Pseudocercospora clematidigena* U. Braun & Crous

corchori Cercospora Sawada, Special Bull. Agric. Exp. Sta. Formosa 19: 37. 1919.

Addition to distribution: Egypt.

Material examined: on *Corchorus olitorius*, Egypt, Tanta, 13 Nov. 1927, from 'Mycol. Div. Egyptian Ministry of Agriculture, Cairo' (NY).

crotalariae *Cercospora* Sacc., Syll. Fung. 22: 129, 1913.

(= *Cercospora apii* s. lat.).

Addition to distribution: USA (Alabama).

Material examined: on *Crotalaria* sp., USA, Alabama, Lee Co., Auburn, 8 Nov. 1897, F.S. Earle (NY).

decolor Cercospora Pass., Anales Soc. Ci. Argent. 9: 191. 1880.

(= *Cercospora apii* s. lat.).

Addition to host range and distribution: *Martynia* sp., USA (Alabama).

Material examined: on *Martynia* sp., USA, Alabama, Tuskegee, 5 Jul. 1877, G.W. Carver 289 (NY).

decumariae Pseudocercospora (Tracy & Earle) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 155. 2003.

Addition to distribution: USA (Alabama).

Material examined: on *Decumaria barbara*, USA, Alabama, Lee Co., Auburn, 11 Aug. 1897, F.S. Earle (NY).

dendrobii **Pseudocercospora** (H.C. Burnett) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 156, 2003.

Addition to host range and distribution: *Dendrobium* sp. (hybrid), Hawaii, Japan.

Material examined: on *Dendrobium* sp., from Japan, intercepted at Hawaii, 24 Jul. 1972, E.S. Shiroma (BPI 435527).

depressa Passalora (Berk. & Broome) Sacc., Nuovo Giorn. Bot. Ital. 8: 187. 1876.

New synonym: *Cladosporium osterici* Ces., in herb. (on *Ostericum verticillare* = *Peucedanum verticillare*, Italy, Prov. di Brescia, Brescia, 1846, Cesati, B 70-6650, 70-6651).

Additions to host range: *Peucedanum decursivum*, *P. ostruthium*, *P. verticillare*.

Notes: *Fusicladium peucedani* Syd. & P. Syd. is a true synonym of *P. depressa* (Deighton 1967). However, *Fusicladium peucedani* Ellis & Holw. is not. The latter species is correctly placed in the genus *Fusicladium* and its inclusion as a synonym of *P. depressa* must be disregarded.

eleocharidis Cercospora Davis ('*eleocharitis*'), Trans. Wisconsin Acad. Sci. 24: 300. 1929.

Notes: The correct Latin spelling of the epithet is '*eleocharidis*'.

erythrinicola Cercospora Tharp, Mycologia 9: 109. 1917.

(= ***Cercospora apii*** s. lat.).

Addition to type material: NY.

Addition to host range and distribution: *Erythrina xinguensis*, Brazil.

Material examined: on *Erythrina xinguensis*, Brazil, Campinas, S. Paulo, 5 Jul.

1935, A.S. Costa 1034 (NY).

forestierae Pseudocercospora* → *Pseudocercospora forestierae (E. West) U. Braun & Crous, **comb. nov.**

MB500179

Fig. 11

= *Cercospora forestierae* E. West, Mycologia 37: 76. 1945.

Lit.: Chupp (1954: 415).

Notes: Type material of this species has not yet been traced, but another collection from Texas has been examined (on *Forestiera* sp., USA, Texas, Lampasas, 1934, C.H. Rogers 565, BPI 450306). This species is well-characterized as follows: Conidiophores fasciculate, arising from substomatal stomata (10–50 μm diam), 10–80(–120) $\times$ 2.5–6 μm , often irregular in width, continuous to septate, olivaceous-brown, conidia solitary, obclavate(-subcylindrical), 15–110 $\times$ 3–6 μm , 1–7-septate, subhyaline to pale olivaceous or olivaceous-brown. On account of inconspicuous conidiogenous loci and unthickened, non-darkened conidial hila, this species has to be reallocated to *Pseudocercospora*.

fuliginosa Pseudocercospora (Ellis & Kellerm.) W.X. Zhao & Y.L. Guo, Acta Mycol. Sinica 12: 195. 1993.

= *Cercospora fuliginosa* Ellis & Kellerm. ('*fuliginosa*'), J. Mycol. 3: 103. 1887.

= *Passalora fuliginosa* (Ellis & Kellerm.) Crous, Alfenas & R.W. Barreto, Mycotaxon 64: 412. 1997.

= *Cercospora atra* Ellis & Everh., J. Mycol. 4: 4. 1888.

Notes: The examination of type material (NY) showed that *Cercospora fuliginosa* belongs in *Pseudocercospora*. The misapplied combination *Passalora fuliginosa* was based on type material of *Cercospora diospyri* Viégas from Brazil which was erroneously reduced to synonymy with *C. fuliginosa* by Chupp (1954). The correct name of *C. diospyri* is *Passalora diospyri* Crous, Alfenas & R.W. Barreto (in Crous & Braun 2003: 163).

fusimaculans Passalora (G.F. Atk.) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 192. 2003.

Addition to host range and distribution: *Buchloë dactyloides*, USA.

Material examined: on *Buchloë dactyloides*, USA, Kansas, Riley Co., NE of Randolph, 16 Jul. 1957, C. T. Rogerson and Chase Co., Cottonwood, 26 Jul. 1957, C.T. Rogerson (NY).

garryae Pseudocercospora* → *Pseudocercospora garryae (Harkn.) U. Braun & Crous, **comb. nov.** MB500180 **Fig. 12**

= *Cercospora garryae* Harkn., Calif. Acad. Sci. Bull. 1: 164. 1884.

Lit.: Saccardo (1886, p. 474), Chupp (1954, p. 176).

Notes: Type material of this species has been re-examined (BPI 436610) and proved to be very meager. The colonies are rather inconspicuous. A few hyphae emerge through stomata, grow superficially and give rise to short solitary conidiophores. The conidia are formed singly, obclavate, $50\text{--}100 \times 3\text{--}4 \mu\text{m}$, 4–8-septate, pale to medium olivaceous, wall smooth, thin to somewhat thickened, apex obtuse to subacute, base obconically truncate, $2 \mu\text{m}$ wide. The conidiogenous loci and conidial hila are unthickened and non-darkened, so that this species has to be assigned to *Pseudocercospora*.

helenii Cercospora Tharp, Mycologia 9: 110. 1917.

Notes: The status of this species is unclear. Type material has been examined (BPI 437051), but it is devoid of any fructification.

hoveniae Cercospora Viégas & Chupp, Boletim Soc. Brasil. Agron. 8: 32. 1945.
(= ***Cercospora apii*** s. lat.).

Addition to type material: NY.

iteodaphnes Cercospora (Thüm.) Sacc., Syll. Fung. 4: 464. 1886.

= *Helminthosporium iteodaphnes* Thüm., Rev. Mycol. 2: 38. 1880.

= *Spiropes scopiformes* (Berk.) M.B. Ellis, Mycol. Pap. 114: 30. 1968.

kamatensis Cercospora Chidd. ('*kamatense*'), Indian Phytopathol. 12: 114. (1959) 1960.

Notes: The status of this species is unclear. Type material has been examined (BPI 437581), but it is devoid of any fructification.

krugiana Cercospora A.S. Mull. & Chupp, Arq. Inst. Bio. Veg. Rio de Janeiro 3: 94. 1936 (*nom. inval.*, Art. 36.1).

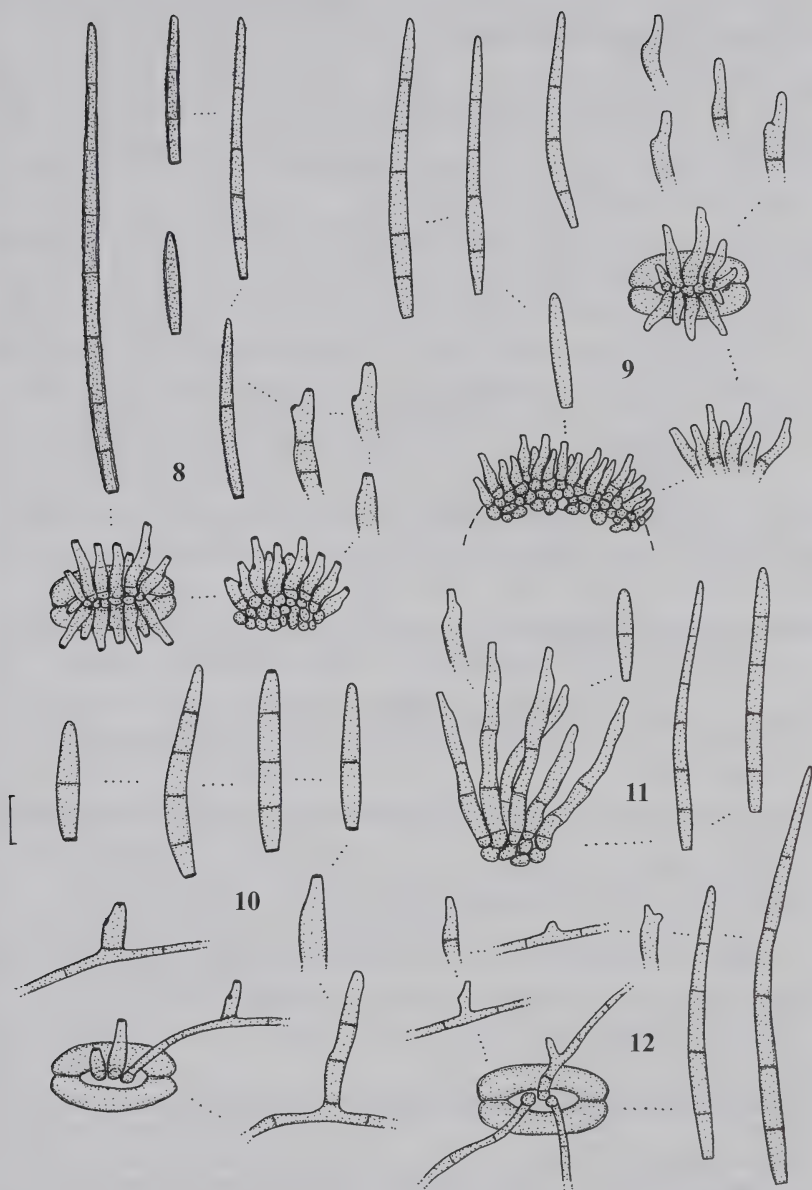
(= ***Cercospora apii*** s. lat.).

Addition to type material: NY.

lactucae Passalora (Henn.) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 240. 2003.

Addition to host range and distribution: *Lactuca* sp., USA (Alabama).

Material examined: on *Lactuca* sp., USA, Alabama, Tuskegee, 3 Aug. 1897, G.W. Carver (NY).



Figs 8–12. Fascicles of conidiophores, conidiophores, conidia, superficial hyphae with solitary conidiophores. **8.** *Stenella hymenocallidis*. **9.** *Pseudocercospora violae*. **10.** *Passalora cardostegiae*. **11.** *Pseudocercospora forestierae*. **12.** *Pseudocercospora garryae*. Scale bar = 10 μ m.

Notes: The North American material agrees well with *P. lactucae* except that the conidiophores are distinctly fasciculate.

laxipes Pseudocercospora U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 245. 2003.

≡ *Cercospora laxipes* Davis, Trans. Wisconsin Acad. Sci. 30: 11. 1937 (*nom. inval.*, Art. 36.1).
Add to type material: BPI 437804 (isotype).

***lemnischea Cercospora* → *Passalora lemnischea* (Cif.) U. Braun & Crous, **comb. nov.** MB500181**

≡ *Cercospora lemnischea* Cif., Ann. Mycol. 36: 235. 1938. [T: Ciferri, Mycofl. Doming. 283, e.g., IMI 59281].

≡ *Cercospora mikaniae* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 43: 90. 1891. [T: BPI 438502; NY], non *Passalora mikaniae* (F. Stevens) U. Braun & F. Freire, 2002.

≡ *Asperisporium mikaniae* (Ellis & Everh.) R.W. Barreto, Mycol. Res. 99: 344. 1995.

≡ *Passalora mikaniigena* U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 275. 2003, *nom. superfl.*

Notes: *Passalora mikaniigena* was introduced as a new name for *Cercospora mikaniae* because the epithet 'mikaniae' was already occupied under *Passalora*. However, the new name is superfluous since the epithet 'lemnischea' of the synonymous species *Cercospora lemnischea* has to be adopted.

lobeliae-cardinalis Passalora (Schwein.) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 254. 2003.

Add to host range and distribution: *Lobelia* sp., USA (Alabama).

Material examined: on *Lobelia* sp., USA, Alabama, Auburn, Oct. 1895, L.M. Underwood (NY).

lychnidis Cercospora H.C. Greene, Trans. Wisconsin Acad. Sci. 47: 116. (1958) 1959.

(= ***Cercospora apii*** s. lat.).

Add to host range and distribution: *Lychnis chalconica*, USA (KS).

Material examined: on *Lychnis chalconica*, USA, Kansas, Riley Co., Campus, Kansas State College, 20 Oct. 1955 and 18 Aug. 1955, C.T. Rogerson (NY).

macromaculans Cercospora Heald & F.A. Wolf, Mycologia 3: 18. 1911.

(= ***Cercospora apii*** s. lat.).

Addition to type material: BPI 438015.

malkoffii Passalora (Bubák) U. Braun, Trudy Bot. Inst. Im. V.L. Komarova 20: 71. 1997.

Add to distribution: Turkey.

Material examined: on *Pimpinella anisum*, Turkey, 2003, S. Maden (HAL 1750), without detailed locality and date.

manihotis Passalora (F. Stevens & Solheim) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 266. 2003.

Add to distribution: Mexico.

Material examined: on *Manihot utilissima*, Mexico, Yucatan, without date, Schott 957 (NY).

marrubii *Cercospora* Tharp, Mycologia 9: 11. 1917.

(= *Cercospora apii* s. lat.).

Addition to type material: BPI 438117.

montenegrina *Cercospora* Bubák, Bot. Közlem. 14: 82. 1915.

Notes: The status of this species could not be elucidated. It is only known from the type collection, which has been examined (BPI 428578). However, this material is almost sterile, without any conidia and only with yellowish brown stromata and a few immature conidiophores without any conidiogenous loci.

pallidissima *Pseudocercospora* (Chupp) Deighton, Mycol. Pap. 140: 149. 1976.

Add to host range and distribution: *Smilax laurifolia*, USA.

Material examined: on *Smilax laurifolia*, USA, Mississippi, Wells Ferry, 14 Sept. 1895, E.S. Earle (NY).

periclymeni *Passalora* (G. Winter) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 315. 2003.

Add to distribution: USA (Wyoming).

Material examined: on *Lonicera* sp., USA, Wyoming, Pahaska Camp Ground, Shoshone National Forerst, 18 Aug. 1942, S.M. Pady (NY).

populicola *Cercospora* Tharp, Mycologia 9: 113. 1917.

(= *Cercospora apii* s. lat.).

Addition to type material: NY.

ramularioides *Passalora* (Sacc. & Fautrey) U. Braun, Schlechtendalia 5: 40. 2000.

Add to distribution: USA (Iowa).

Material examined: on *Leersia* sp., USA, Iowa, Story Co., Ames, 13 Aug. 1887, A.S. Hitchcock (NY).

rumicis *Cercospora* Pavgi & U.P. Singh, Mycopathol. Mycol. Appl. 23: 191. 1964.

(= *Cercospora apii* s. lat.).

Add to host range and distribution: *Rumex* sp., USA (Alabama).

Material examined: on *Rumex* sp., USA, Alabama, Auburn, 25 Oct. 1896, C.F. Baker (NY).

tecomae *Cercospora* Chupp & Viégas, Boletim Soc. Brasil. Agron. 8: 53. 1945.

(= *Cercospora apii* s. lat.).

Addition to type material: NY.

tinosporeae *Phaeoramularia* Kamal, A.S. Moses & R.K. Chaudhary, Mycol. Res. 94: 715. 1990.

≡ *Pseudocercospora tinosporeae* (Kamal, A.S. Moses & R.K. Chaudhary) U. Braun, Schlechtendalia 5: 53 (2000), *nom. illeg.*, non *P. tinosporeae* A.N. Rai & Kamal, 1989.

≡ *Pseudocercospora tinosporigena* U. Braun, **nom. nov.** MB500182

(Replaced synonym: *Phaeoramularia tinosporae* Kamal, A.S. Moses & R.K. Chaudhary, Mycol. Res. 94: 715. 1990).

Notes: Braun (2000) examined type material of *Phaeoramularia tinosporae* and, based on the presence of inconspicuous conidiogenous loci, assigned this species to *Pseudocercospora*. However, the proposed combination proved to be a later homonym of *Pseudocercospora tinosporae* A.N. Rai & Kamal.

truncatella Cercospora G.F. Atk., J. Elisha Mitchell Sci. Soc. 8: 44. 1892.

(= *Cercospora apii* s. lat.).

Add to distribution: USA (Alabama).

Material examined: on *Passiflora incarnata*, USA, Alabama, Lee Co., Auburn, 21 Oct. 1897, F.S. Earle & C.F. Baker (NY).

venturioides Passalora (Peck) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 419. 2003.

= *Cercospora illionensis* Barthol., Fungi Columb. 2611. 1908 (with description on the label). [T: Barthol. Fungi Columb. 2611, e.g., HBG, NY].

Notes: The epithet '*illionensis*' was missing in Crous & Braun (2003).

zeae-maydis Cercospora Tehon & E.Y. Daniels, Mycologia 248. 1925.

Add to distribution: USA (Alabama).

Material examined: on *Zea mays*, USA, Alabama, Tuskegee, G.W. Carver, No. 352 (NY).

Corrections to the 'Index to fungus names by host genus' in Crous & Braun (2003)

Hovea

hoveae Cercospora

Notes: '(= *Cercospora apii* s. lat.)' has to be cancelled.

Hovenia

hoveniae Cercospora (= *Cercospora apii* s. lat.)

Notes: '(= *Cercospora apii* s. lat.)' has to be added.

Melilotus

meliloti Cercospora

davisii Cercospora

Notes: *C. davisii* is missing in Crous & Braun (2003) and has to be added.

Peucedanum

depressa Passalora

Notes: *P. depressa* is missing in Crous & Braun (2003) and has to be added.

Rumex*acetosellae* *Pseudocercospora**peckiana* *Cercospora**rumicis* *Cercospora* (= *Cercospora apii* s. lat.)

Notes: *Cercospora rumicis* is missing in Crous & Braun (2003) and has to be added. '(= *Cercospora apii* s. lat.)' has to be cancelled under *Cercospora peckiana*. The latter species is quite distinct from the *C. apii* complex.

Acknowledgements

Sincere thanks are due to the curators and directors of the herbaria B, BPI and NY (abbreviations according to Holmgren et al. 1990) for allowing us to examine type material and other collections in their keeping. Drs Frank Hill and Walter Gams are thanked for their comments on the script.

Literature Cited

- Boedijn KB. 1961. The genus *Cercospora* in Indonesia. *Nova Hedwigia* 3: 411-436.
- Braun U. 1994. Miscellaneous notes on phytopathogenic hyphomycetes. *Mycotaxon* 51: 37-68.
- Braun U. 1995. A monograph of *Cercosporiella*, *Ramularia* and allied genera (Phytopathogenic Hyphomycetes). Vol. 1. IHW-Verlag, Eching (333 pp.).
- Braun U. 2000. Miscellaneous notes on some micromycetes. *Schlechtendalia* 5: 31-56.
- Braun U. 2001. Revision of *Cercospora* species described by K.B. Boedijn. *Nova Hedwigia* 73: 419-436.
- Braun U, Mel'nik VA. 1997. Cercosporoid fungi from Russia and adjacent countries. *Trudy Bot. Inst. Komarova Rossijsk. Akad. Nauk, St. Petersburg*, 20: 1-130.
- Braun U, Mouchacca J, McKenzie EHC. 1999. Cercosporoid hyphomycetes from New Caledonia and some other South Pacific islands. *New Zealand J. Bot.* 37: 297-327.
- Chupp C. 1954. A monograph of the fungus genus *Cercospora*. Ithaca, New York. Published by the author.
- Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Series 1: 1-569, Utrecht.
- Deighton FC. 1967. Studies on *Cercospora* and allied genera. II. *Passalora*, *Cercosporidium* and some species of *Fusicladium* on *Euphorbia*. *Mycol. Pap.* 112: 1-80.
- Deighton FC. 1987. New species of *Pseudocercospora* and *Mycovellosiella*, and new combinations into *Pseudocercospora* and *Phaeoramularia*. *Trans. Brit. Mycol. Soc.* 88: 365-391.
- Goh TK, Hsieh WH. 1989. Studies on *Cercospora* and allied genera of Taiwan (VI). *Trans. Mycol. Soc. Republ. China* 4: 1-23.
- Govindu HC, Thirumalachar MJ. 1955. Notes on some Indian Cercosporae – VI. *Sydowia* 9: 221-228.
- Guo YL, Hsieh WH. 1995. The genus *Pseudocercospora* in China. *Mycosystema Monographicum* 2: 1-388.
- Guo YL. (2001). Studies on *Cercospora* and allied genera in China IX. *Mycosystema* 20: 301-303.
- Guo YL, Liu XJ, Hsieh WH. 1998. *Flora Fungorum Sinicorum*, Vol. 9, *Pseudocercospora*. Beijing.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part 1: The Herbaria of the World. 8th edn. *Regnum Vegetabile* 120: 1-163.

- Hsieh WH, Goh TK. 1990. *Cercospora* and similar fungi from Taiwan. Taipei.
- Katsuki S. 1965. Cercosporae of Japan. Trans. Mycol. Soc. Japan, Extra Issue 1: 1-100.
- Kirschner R, Piepenbring M, Chen CJ. 2004. Some cercosporoid hyphomycetes from Taiwan, including a new species of *Stenella* and new reports of *Distocercospora pachyderma* and *Phacellium paspali*. Fungal Diversity 17: 57-68.
- Nakashima C, Nishijima T, Kobayashi T. 1999. Addition and reexamination of Japanese species belonging to the genus *Cercospora* and allied genera II. Species described by Japanese mycologists (1). Mycoscience 40: 269-276.
- Shin HD, Braun U. 2000. Notes on Korean Cercosporae and allied genera (III). Mycotaxon 74: 105-118.
- Singh PN, Singh SK, Tripathi SC. 1996. New species of *Pseudocercospora* causing leaf spots of forest plants in Nepal. Mycol. Res. 100: 1129-1132.
- Yen JM, Lim G. 1980. *Cercospora* and allied genera of Singapore and the Malay Peninsula. Gard. Bull., Singapore 33: 151-263.

Taxonomic studies of *Corynespora* from China

XIU-GUO ZHANG* & CHENG-KUEI SHI

Zhxxg@sdaa.edu.cn

Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract—This paper provides descriptions and illustrations of three new species in the hyphomycete genus *Corynespora*: *C. tectonae*, *C. saccharum* and *C. toonae* occurring on the hosts *Tectona grandis*, *Saccharum sinense* and *Toona sinensis*, respectively.

Key words—hyphomycetes, dematiaceous

Introduction

The genus *Corynespora* Güssow was established by Güssow (1906). Wei (1950), Ellis (1957, 1963, 1971), Morgan-Jones (1988), Sutton and Pascoe (1988) and Meenu (1997) have precisely defined the distinctive features of the genus. *Corynespora* has monotretic, determinate or percurrently extending conidiogenous cells on unbranched conidiophores, and cylindrical, obclavate to slightly ellipsoid, distoseptate, solitary or catenate conidia, which usually exhibit a conspicuous darkened scar or truncate base, are pigmented, septate or pseudoseptate, smooth in most species, and verrucose in only a few. A stroma present in some species. A majority of species of *Corynespora* occurs on the foliage of more than 50 genera of plants from a number of tropical or subtropical countries (Ellis 1957, Wei 1950). Only 4 species have previously been described from China (Guo 1984). This study presents a survey of *Corynespora* species occurring on deciduous stems or rotten wood of subtropical or tropical regions in China.

Materials and Methods

Specimens of deciduous stems or rotten wood were collected from various subtropical and tropical localities during 2001–2004. All specimens were examined in the laboratory and then deposited in the herbarium of Plant Pathology, Shandong Agricultural University (HSAUP). Microscope slides were prepared in lactophenol and glycerin solution from the scrapings taken from superficial of deciduous stem or rotten wood. The slides were examined and camera lucida drawings were prepared to show the most diagnostic characters. The taxonomic determinations were made from descriptions in the literature.

* Corresponding author

Taxonomic Description

Corynespora tectonae X. G. Zhang & Ch. K. Shi, sp. nov.

FIGURE 1

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-5 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 0-3 proliferationes percurrentes successivas cylindricae, 50-80 µm longa, 4-5 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, verrucosa vel laevia, pallide brunnea vel olivaceo-brunnea, 12-18-pseudoseptata, 110-160 µm longa, 10-12 µm crassa, apicem versus ad 2-3 µm attenuata.

Etymology: *tectonae*, in reference to the host, *Tectona grandis* L.

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-5 µm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 3 successive percurrent cylindrical proliferations, 50-80×4-5 µm. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or curved, obclavate, tapering toward the apex, verrucose or smooth, pale brown to olivaceous brown, 12-18-pseudoseptate, 110-160 µm long, 10-12 µm thick in the broadest part, tapering to 2-3 µm near the apex. Lower cells dark brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Tectona grandis* L., Arboretum of Huanan, Guangdong Province, China. Oct. 20. 2003, X. G. Zhang, HSAUPIII₀0584.

The new species differs from *C. obclavata* (Dyko & Sutton 1979) and *C. foveolata* (Hughes 1958) in its longer conidia (110-160 µm). In addition, some conidia of the new taxon have many pseudosepta (12-18) and are often verrucose, while conidia of *C. obclavata* and *C. foveolata* have only 4-6 or 4-11 septa and most are smooth or only slightly verrucose.

Corynespora saccharume X. G. Zhang & Ch. K. Shi, sp. nov.

FIGURE 2

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, subhyalinis vel brunneis, laevibus, 2-7 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 1-2 proliferationes percurrentes successivas cylindricas elongascentia, 70-110 µm longa, 4-5 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, verrucosa vel laevia, pallide brunnea vel olivaceo-brunnea, 10-14-septata, 80-120 µm longa, 8-9 µm crassa, apicem versus ad 2-3 µm attenuata.

Etymology: *saccharume*, in reference to the host, *Saccharum sinense* L.

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 2-7 µm thick.



Fig. 1 Conidia and conidiophores of *C. tectonae*

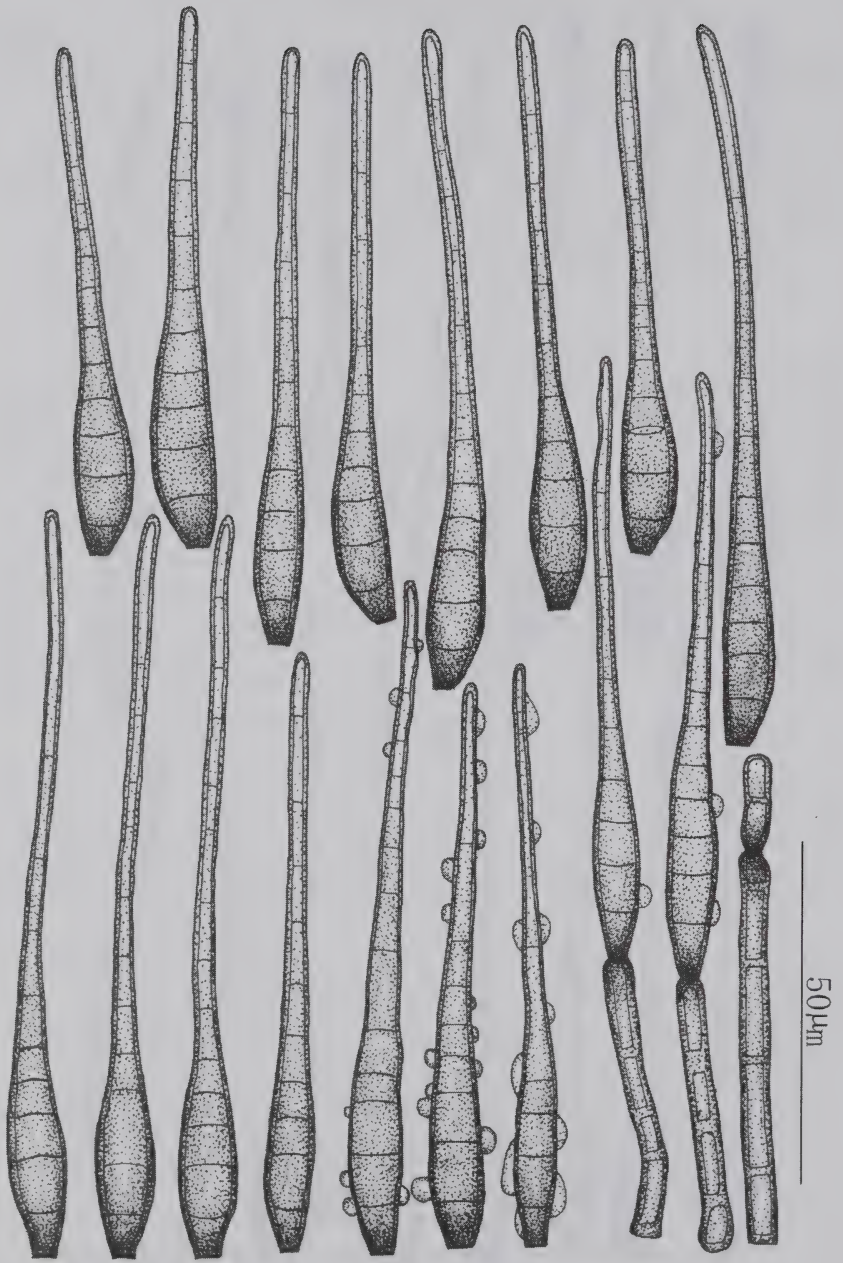


Fig. 2 Conidia and conidiophores of *C. saccharume*

Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 2 successive percurrent cylindrical proliferations, $70\text{--}110 \times 4\text{--}5\text{ }\mu\text{m}$. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or curved, obclavate, tapering to the apex, verrucose or smooth, pale brown to olivaceous brown, $10\text{--}14$ -septate, $80\text{--}120\text{ }\mu\text{m}$ long, $8\text{--}9\text{ }\mu\text{m}$ thick in the broadest part, tapering to $2\text{--}3\text{ }\mu\text{m}$ near the apex. Lower cells slightly darker brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Saccharum sinense* R., Arboretum of Gueilin, Guangxi Province, China. Oct. 12. 2003, X. G. Zhang, HSAUPIII, 0495.

In conidial morphology, this species resembles *C. foveolata* (Hughes, 1958) in shape. However, the new taxon can be separated from *C. foveolata* by its longer conidia with more numerous septa. In addition, the conidiophores of the new species have only 1-2 successive proliferations, while those of *C. foveolata* have 7.

***Corynespora toonae* X. G. Zhang & Ch. K. Shi, sp. nov.**

FIGURE 3

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide olivaceo-brunnea vel olivaceo-brunnea, laevibus, 2-6 }\mu\text{m crassis compositum. Stromata nulla. Conidiophora singula vel fasciculate, erecta, simplicia vel nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 4 proliferationes percurrentes successivas cylindricas elongascentia, 40-112 }\mu\text{m longa, 4-5 }\mu\text{m crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, laevia, pallide brunnea vel atro-brunnea, 0-4-pseudoseptata vel 4-14-septata, 65-144 }\mu\text{m longa, 7-9 }\mu\text{m crassa, apicem versus ad 2-4 }\mu\text{m attenuata.}

Etymology: *toonae*, in reference to the host, *Toona sinensis* R.

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale olivaceous brown to olivaceous brown, smooth-walled hyphae, $2\text{--}6\text{ }\mu\text{m}$ thick. Stroma absent. Conidiophores arising singly or in groups terminally, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 4 successive percurrent cylindrical proliferations, $40\text{--}112 \times 4\text{--}5\text{ }\mu\text{m}$. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or curved, obclavate, tapering toward the apex, smooth-walled, pale brown to dark brown, $0\text{--}4$ -pseudoseptate or $4\text{--}14$ -septate, $65\text{--}144\text{ }\mu\text{m}$ long, $7\text{--}9\text{ }\mu\text{m}$ thick in the broadest part, tapering to $2\text{--}4\text{ }\mu\text{m}$ near the apex. Lower cells brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Toona sinensis* R., Arboretum of Nanning, Guangxi Province, China. Oct. 20. 2003, X. G. Zhang, HSAUPIII, 0402.

The conidia of this species are similar to those of *C. foveolata* (Hughes, 1958). However, the conidia in the new taxon ($65\text{--}144\text{ }\mu\text{m}$) are longer than those of *C. foveolata* ($28\text{--}100\text{ }\mu\text{m}$). The conidia of the new taxon are also smooth-walled and $0\text{--}4$ -pseudoseptate, as



Fig.3 Conidia and conidiophores of *C. toonae*

opposed to those of *C. foveolata*, which are verrucose or smooth-walled and have no pseudosepta.

Acknowledgments

The authors are indebted to B. Kendrick and N. R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Science Foundation of China (no.30370009).

Literature Cited

- Dyko BJ, Sutton BC. 1979. New and interesting dematiaceous Hyphomycetes from Florida. *Mycotaxon* VIII. 1:119-124.
- Ellis MB. 1957. Some species of *Corynespora*. *Mycological Papers* 65:1-15.
- Ellis MB. 1963. Dematiaceous hyphomycetes IV. *Mycological Papers* 87:1-42.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Kew: Commonwealth Mycological Institute 372-376.
- Guo YL. 1984. Four new species of the genus *Corynespora*. *Acta Mycologica Sinica* 3(3):161-169.
- Güssow HT. 1906. Über eine neue Krankheit an Gurken in England *Z. Pflkrankh.* 76:10-13.
- Hughes SJ. 1958. Revisiones Hyphomycetes aliquot cum appendice de nominibus rejiciendis. *Canadian Journal of Botany* 36:727-836.
- Morgan-Jones G. 1988. Notes on Hyphomycetes LX. *Mycotaxon* 33:483-489.
- Meenu AS, Singh SK. 1997. Some new species of *Corynespora*. *Indian Phytopathology* 50 (1):17-24
- Sutton BC, Pascoe IG. 1988. Some dematiaceous hyphomycetes from branches and phyllodes of *Acacia* in Australia. *Australian Systematic Botany* 1:127-138.
- Wei CT. 1950. Notes on *Corynespora*. *CMI. Mycological Papers* 34:1-9.

Taxonomic studies of *Corynespora* from Yunnan, ChinaXIU-GUO ZHANG* & MIN JI¹

Zhxxg@sdaa.edu.cn

*Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China¹Academy of Agricultural Science
Shandong, Taian, 271000, China

Abstract—*Corynespora rhaps-humilisi* sp. nov. and *C. flagellatum* comb. nov. are described from Heikou tropical forest in Yunnan. Six new records are illustrated from the same area.

Key words—hyphomycetes, new combination, *Podoconis*, *Sporidesmium*

Introduction

The Heikou forest of Yunnan province is a tropical area of China. More than 150 specimens of hyphomycetes were collected from bark stems or rotten wood. a species new to science, a second species here transferred to *Corynespora*, and six other species new to the Yunnan were found.

Taxonomic Description

Corynespora rhaps-humilisi X.G. Zhang & M. Ji, sp. nov.

FIGURE 1

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-3 µm crassis, compositum. Stromata nulla. Conidiophora singula vel fasciculata, simplicia vel nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea, per usque ad 1-2 proliferationes successivas cylindricae elongascentia, 30-45 µm longa, 3-4 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, laevibus, ad bqsim truncata, pallide olivaceo-brunnea vel olivaceo-brunnea, 12-16-pseudoseptata vel 1-4-septata, 90-130 µm longa, 6-8 µm crassa, apicem versus ad 1 µm attenuata, basi 2-3 µm lata.

Etymology: *rhaps-humilisi*, in reference to the host, *Rhapis humilis* B.

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-3 µm thick. Stroma absent. Conidiophores arising singly or in groups, unbranched, straight or flexuous,

* Corresponding author



Fig. 1 Conidia and conidiophores of *C. rhaps-humilisi*

cylindrical, septate, smooth-walled, brown, with up to 2 successive lageniform proliferations, $30\text{--}45 \times 3\text{--}4\text{ }\mu\text{m}$. Conidia formed singly at the apex of the conidiophore which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or curved, obclavate, attenuated or rostrate, tapering toward the apex, smooth-walled, truncate at the base, pale olivaceous brown to olivaceous brown, 12–16-pseudoseptate or 1–4-septate, $90\text{--}130\text{ }\mu\text{m}$ long, $6\text{--}8\text{ }\mu\text{m}$ thick in the broadest part, tapering to $1\text{ }\mu\text{m}$ near the tip, $2\text{--}3\text{ }\mu\text{m}$ wide at the base. Lower cells dark brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Rhapis humilis* B., Tropical forest of Heikou, Yunnan Province, China. Oct. 26. 2003, X. G. Zhang, HSAUPIII0 0573.

The characters of the conidiophore proliferations and conidiogenous cells in this fungus are consistent with those of the genus *Corynespora* (Güssow 1906, Wei 1950, Ellis 1957, 1971, Morgan-Jones 1988). But it differs from all other taxa classified in this genus in conidial shape.

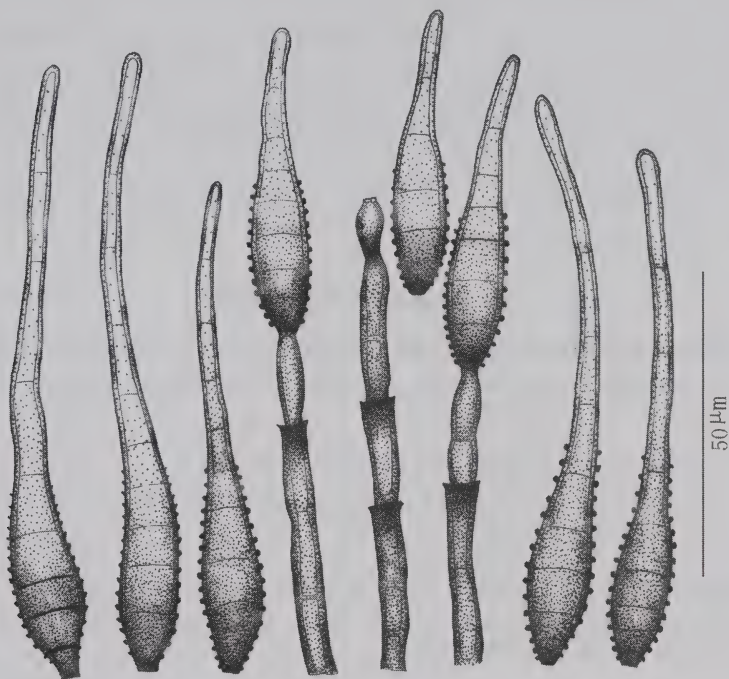


Fig. 2 Conidia and conidiophores of *C. flagellatum*

Corynespora flagellatum (S. Hughes) X.G. Zhang & M. Ji, **comb. nov.**

FIGURE 2

Basionym: *Podoconis flagellata* S. Hughes, 1953, Mycol. Pap. 50: 57

= *Sporidesmium flagellatum* (S. Hughes) Ellis, 1958, Mycol. Pap. 70: 54

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 2-4 μm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, brown to dark brown, paler near the apex, septate, smooth-walled, with up to 3 successive percurrent cylindrical proliferations, 55-290 $\times$ 4-7 μm . Conidia formed singly at the apex of the conidiophore which then sometimes proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or slightly curved, obclavate, attenuated or rostrate, conico-truncate at the base, 5-10-septate, 50-100 μm long, 9-11 μm thick in the broadest part, tapering to 2-3 μm near the tip, 4-5 μm wide at the base. Lower cells dark brown, often verrucose, upper cells smooth-walled, becoming gradually paler toward the apex.

Holotype here designated: On rotten wood of *Quercus albus* L., Tropical forest of Heikou, Yunnan Province, China. Oct. 26. 2003, X. G. Zhang, HSAUPIII0 0418.

With respect to presence of annellation or percurrent proliferations on the conidiophore and the shape of conidia, Hughes (1953) classified this fungus in the genus *Podoconis* Boedijn. But Ellis (1958) surveyed the characters of the conidiophore and conidia of some taxa in *Podoconis* and recognized these as belonging to *Sporidesmium* Link. Other taxa still classified in *Podoconis* should undoubtedly be placed in *Sporidesmium*. The conidiophore in *Corynespora* is, however, quite different from that in *Sporidesmium*. The conidiophore of *Sporidesmium* is often conico-truncate at the apex, while that of the *Corynespora* is often number successive percurrent cylindrical proliferations and form doliiform or lageniform constrictions or occasionally some rest of margin of the wall after proliferation. This fungus conforms to the essential characteristics of *Corynespora* in all respects and differs from all other species in the conidial shape. Therefore, it should be transferred to this genus.

New records from China

Corynespora cassicola (Berk. & M.A. Curtis) C.T. Wei, 1957, Mycol. Pap. 65:13

On rotten stem of *Canarium tonkinense* E., Heikou, Yunnan Province, China. Oct. 20. 2003, X. G. Zhang, HSAUPIII0 0515.

Corynespora combreti M.B. Ellis, 1963, Mycol. Pap. 93:30

On rotten wood of *Quercus albus* L., Heikou, Yunnan Province, China. Oct. 22. 2003, X. G. Zhang, HSAUPIII0 0418.

Corynespora homaliicola Deighton & M.B. Ellis, 1957, Mycol. Pap. 65:14

On rotten stem of *Pterostyrax leveillei* L., Heikou, Yunnan Province, China. Oct. 20. 2003, X. G. Zhang, HSAUPIII0 0509.

Corynespora lanneicola Deighton & M.B. Ellis, 1957, Mycol. Pap. 65:11

On rotten stem of *Lindera supracostata* L., Heikou, Yunnan Province, China. Oct. 22. 2003, X. G. Zhang, HSAUPIII0 0510.

Corynespora obclavata Dyko & B. Sutton, 1979, Mycotaxon VIII 1:121

On rotten stem of *Tournefortia montana* L., Heikou, Yunnan Province, China. Oct. 21. 2003, X. G. Zhang, HSAUPIII0 0541.

Corynespora smithii (Berk. & Broome) M.B. Ellis, 1957, Mycol. Pap. 65:3

On rotten stem of *Litsea garrettii* G., Heikou, Yunnan Province, China. Oct. 26. 2003, X. G. Zhang, HSAUPIII0 0506.

Acknowledgments

The authors are indebted to B. Kendrick and N. R. O' Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Science Foundation of China (no. 30370009).

Literature Cited

- Dyko BJ, Sutton BC. 1979. New and interesting Dematiaceous Hyphomycetes from Florida. Mycotaxon VIII 1:119-124.
- Ellis MB. 1957. Some species of *Corynespora*. Mycological Papers 65:1-15.
- Ellis MB. 1971. Dematiaceous Hyphomycetes. Kew: Commonwealth Mycological Institute 372-376.
- Ellis MB. 1963. Dematiaceous Hyphomycetes. IV. Mycological Papers 87:1-42.
- Güssow HT. 1906. Über eine neue Krankheit an Gurken in England Z. Pflkrankh.76:10-13.
- Morgan-Jones G. 1988. Notes on Hyphomycetes LX. Mycotaxon 33:483-489.
- Wei CT. 1950. Notes on *Corynespora*. CMI. Mycological Papers 34:1-9.

Taxonomic studies of *Corynespora* from Guangxi, ChinaXIU-GUO ZHANG* & JUN-JIE XU¹

Zhxxg@sdau.edu.cn

*Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China¹College of Life Science, Lin Yi Normal University
Lin Yi, 276005, China

Abstract—This paper provides descriptions and illustrations three new species in the hyphomycete genus *Corynespora* from deciduous stems or rotten wood. *C. ficus-altissimae*, *C. donae* and *C. phyllosthureae* occurred on the hosts *Ficus altissima*, *Dona*, and *Phyllostachys sulphurea*, respectively.

Key words—hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on deciduous stems or rotten wood from Guangxi province in south China revealed three previously undescribed species of *Corynespora* Güssow. The first two species were collected from the Arboretum of Nanning and the third from a forest at Guangxi. The specimens from deciduous stems or rotten wood were collected from subtropical localities of Guangxi province in China during 2003.

Taxonomic Descriptions

Corynespora ficus-altissimae X.G. Zhang & J.J. Xu, sp. nov.

FIGURE 1

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunnea vel brunnea, laevibus, 2–4 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea vel atro-brunnea, per usque ad 1–3 proliferationes successivas cylindricae vel cupulatae, 30–65 µm longa, 5–6 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, 1–2 successivae innera conidium, recta vel curvata, obclavata, longe attenuata, laevia, ad basim truncata, atro-brunnea vel fusca, 11–18-pseudoseptata, 55–85 µm longa, 9–12 µm crassa, apicem versus ad 3–4 µm attenuata, basi 2–3 µm lata.

Etymology: *ficus-altissimae*, in reference to the host, *Ficus altissima* L.

* Corresponding author

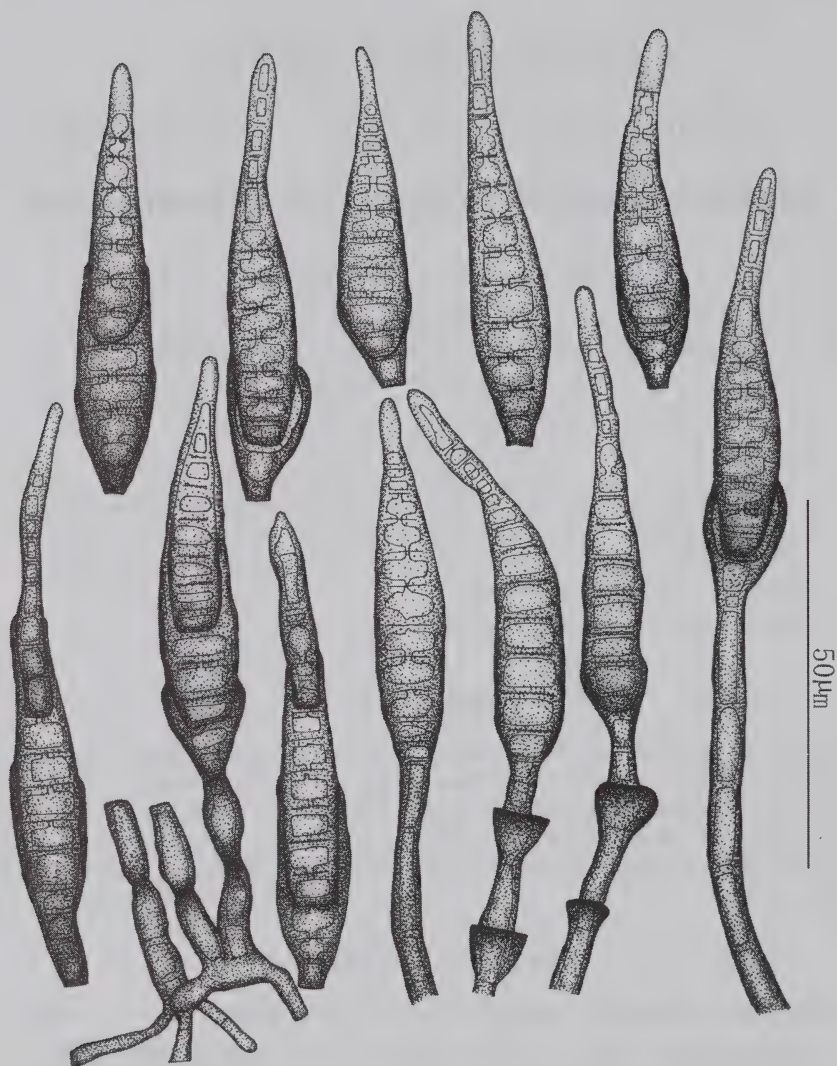


Fig. 1 Conidia and conidiophores of *C. ficus-altissimae*

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-4 μm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, brown to dark brown, with up to 3 successive cylindrical percurrent proliferations, 30-65 $\times$ 5-6 μm . Conidia formed singly through a pore or a cupule at the apex of the conidiophore or previous conidium, straight or curved, obclavate, tapering to the apex, smooth-walled, truncate at the base,

dark brown to blackish brown, 11-18-pseudoseptate, 55-85 μm long, 9-12 μm thick in the broadest part, tapering to 3-4 μm near the apex, 2-3 μm wide at the truncate basal scar. Lower cells dark brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Ficus altissima* L., Arboretum of Nanning, Guangxi Province, China. Oct. 15. 2003, X. G. Zhang, HSAUPIII0 0424.

The conidia of *Corynespora ficus-altissimae* are similar to those of *C. gigaspora* (Ellis 1957) and *C. siwalika* (Ellis 1971), but are smaller. In addition, the conidiophore in the new species occasionally proliferates straight through the cupule and forms new conidia.

Corynespora donae X.G. Zhang & J.J. Xu, sp. nov.

FIGURE 2

Coloniae fuscae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2-5 μm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, atro-brunnea, per usque ad 1 proliferatione cylindrica elongascentia, 70-90 μm longa, 4-5 μm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda. Conidia recta vel curvata, obclavata, longe attenuata, laevia, ad basim truncata, olivaceo-brunnea, 10-14-pseudoseptata, 45-70 μm longa, 8-12 μm crassa, apicem versus ad 3-5 μm attenuata, cinctae truncato basalem 2-3 μm lata.

Etymology: *donae*, in reference to the host, *Dona* L.

Colonies blackish brown, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-5 μm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, dark brown, often with apical cylindrical proliferation, 70-90 $\times$ 4-5 μm . Conidia formed singly through a pore at the apex of the conidiophore or through successive percurrent proliferations. Conidia straight or curved, obclavate, tapering to the apex, smooth-walled, truncate at the base, olivaceous brown, 10-14-pseudoseptate, 45-70 μm long, 8-12 μm thick in the broadest part, tapering to 3-5 μm near the apex, 2-3 μm wide at the truncate basal scar. Lower cells brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Dona* L., Arboretum of Nanning, Guangxi Province, China. Oct. 15. 2003, X. G. Zhang, HSAUPIII0 0493.

The conidia of *Corynespora donae* are smaller than those of *C. gigaspora* (Ellis 1975) and *C. siwalika* (Ellis 1971), and the mature conidia of *C. donae* have fewer pseudosepta (av. 12) than those of *C. gigaspora* (av. 32) and *C. siwalika* (av. 24).

Corynespora phylloshureae X.G. Zhang & J.J. Xu, sp. nov.

FIGURE 3

Coloniae fuscae vel atrae, effusae. Mycelium immersum vel superficiales, ex hyphis ramosis, septatis, pallide brunnea vel brunnea, laevibus, 2-4 μm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea vel fusca, per usque ad 3 proliferationes successivas cylindricas elongascentia, 45-75 μm longa, 4-5 μm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, laevia, pallide brunnea vel atro-brunnea, 6-10-

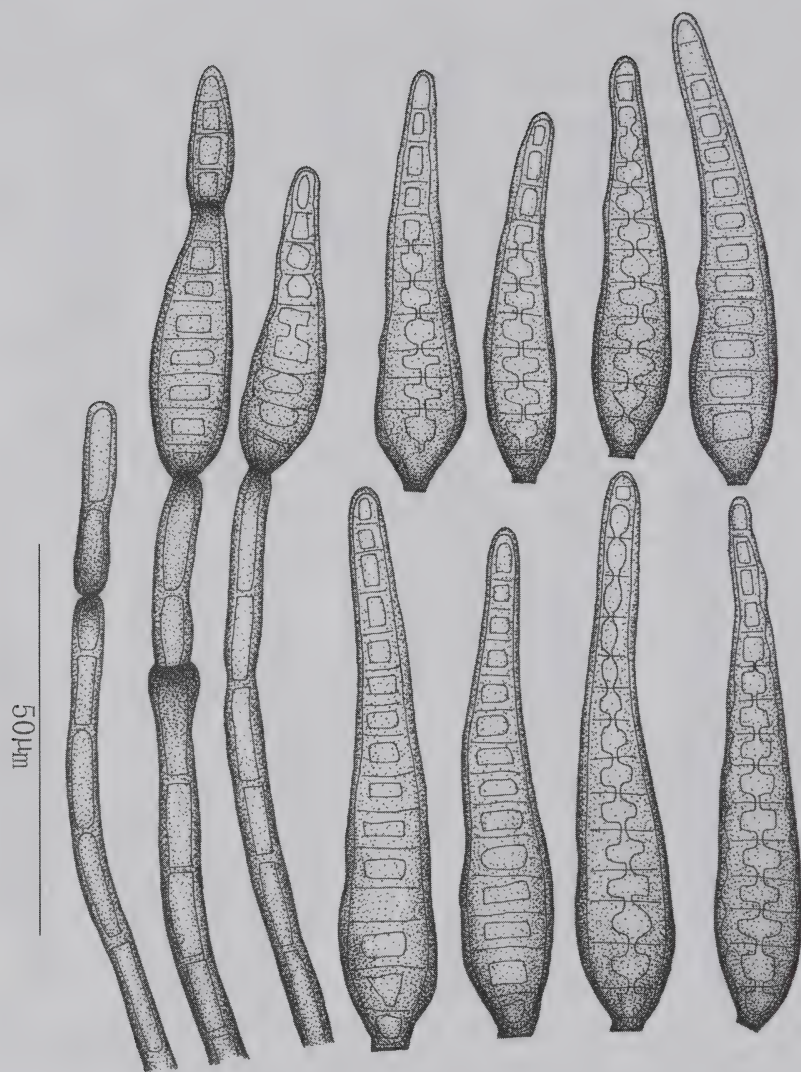


Fig. 2 Conidia and conidiophores of *C. donae*

pseudoseptata, 30-50 μm longa, 8-10 μm crassa, apicem versus ad 3-4 μm attenuata, basi 2-3 μm lata.

Etymology: *phylloshureae*, in reference to the host, *Phyllostachys sulphurea* (Carr.) R.

Colonies dark blackish brown to black, effused. Mycelium immersed or superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-4 μm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, brown to blackish brown,

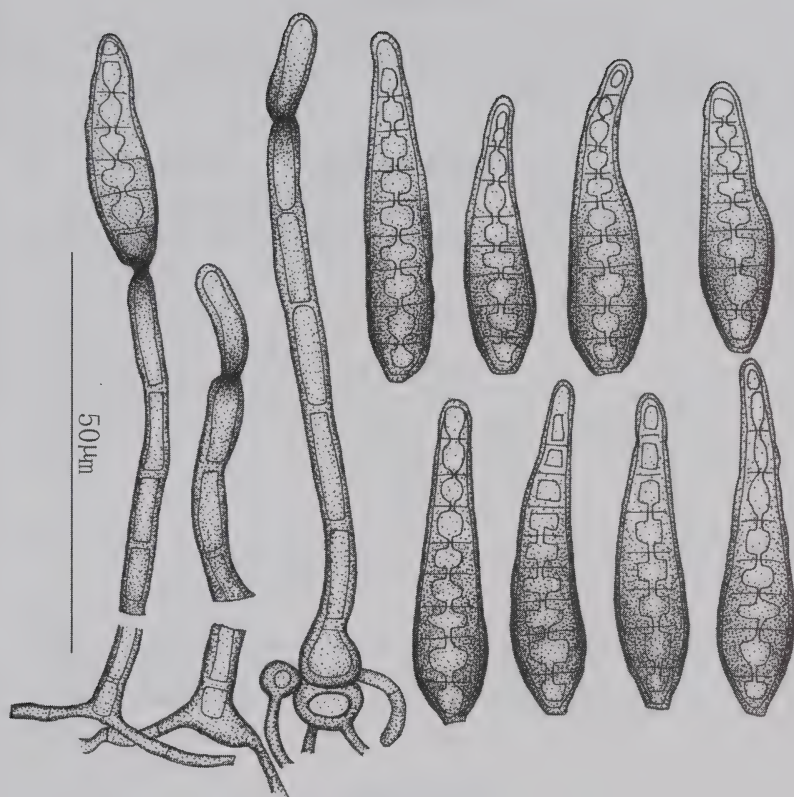


Fig. 3 Conidia and conidiophores of *C. phyllosthureae*

with up to 3 successive percurrent cylindrical proliferations, $45\text{--}75 \times 4\text{--}5\text{ }\mu\text{m}$. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the new apex. Conidia straight or curved, obclavate, tapering toward the apex, smooth-walled, pale brown to dark brown, 6–10-pseudoseptate, $30\text{--}50\text{ }\mu\text{m}$ long, $8\text{--}10\text{ }\mu\text{m}$ thick in the broadest part, tapering to $3\text{--}4\text{ }\mu\text{m}$ near the apex, $2\text{--}3\text{ }\mu\text{m}$ wide at the base. Lower cells brown, upper cells becoming gradually paler toward the apex.

Holotype here designated: on dead branches of *Phyllostachys sulphurea* (Carr.) R., forest in Gueilin, Guangxi Province, China. Oct. 12. 2003, X. G. Zhang, HSAUPIII0 0496.

The conidia of *Corynespora phyllosthureae* are similar to those of *C. gigaspora* (Ellis 1957) and *C. siwalika* (Ellis 1971), but are smaller. In addition, conidia of this new species have a much less obvious truncate scar at the base than is seen in the other two species.

Acknowledgments

The authors are indebted to B. Kendrick and N. R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Science Foundation of China (no. 30370009).

Literature Cited

- Ellis MB. 1957. Some species of *Corynespora*. Mycological Papers 65:1-15.
Ellis MB. 1971. Dematiaceous hyphomycetes. Kew: Commonwealth Mycological Institute. 372-376.

Preliminary checklist of the basidiomycetes from mediterranean inland dune ecosystems of Seville (Spain)

A. ORTEGA

aortega@ugr.es

*Departamento de Botánica, Facultad de Ciencias, Universidad de Granada
18071 Granada, Spain*

F. ESTEVE-RAVENTÓS

fernando.esteve@uah.es

*Departamento de Biología Vegetal, Facultad de Biología, Universidad de Alcalá
28801 Alcalá de Henares, Madrid, Spain*

Abstract—The preliminary taxonomic list of 104 basidiomycetes species native to the inland dune ecosystems in Seville (Spain) is summarized. The complete checklist can be downloaded from <http://www.mycotaxon.com/resources/weblists.html>

Key words—taxonomy

Introduction

The mycological richness of Mediterranean ecosystems is impressive, as demonstrated by the numerous bibliographical references available in countries like France, Italy and Spain. Recently, Ortega (2003) compiled mycological data from the Guadamar river basin (provinces of Huelva and Seville), an area that in April, 1998, suffered severe ecological damage from the breaking of a mine pond (property of the Swedish-Canadian enterprise Boliden), which liberated massive quantities of toxic mineral wastes. This event led to the implementation of a research program named “Programa de Investigación del Corredor Verde del Guadamar”, e.g. PICOVER, aiming at the remediation of this environmental disaster.

One area studied in Ortega’s work is located close to the sevilian town of Aznalcázar (see map), where a ~3 km² plot was sampled during three consecutive years (2000–2002). This small area is dominated by typical mediterranean plant communities developing on sandy soils that belong to the plant association *Myrto communis-Querceto suberis halimietoso halimiifolii* S., e.g., xero-psammophilous, thermomediterranean cork-oak open woodlands. These open “alcornocales” are often intermixed with *Pinus pinea* and *Quercus ilex* subsp. *ballota* and more rarely with *Eucalyptus* spp. Diverse shrubs, like “lentiscos” (*Pistacia lentiscus*), “mirtos” (*Myrtus communis*) or “jaras” (*Cistus* spp.)

are sometimes present in somewhat more degraded areas (Cabezudo et al. 2003). This plot, which has been heavily influenced by human activity, also includes an abundance of burned wood residues, rotten plant debris, and cattle dung.

Biogeographically, the Guadiamar river basin is included within the chorological province Gaditano-Onubo-Algarviense, sector Gaditano-Onubense (Rivas-Martínez et al. 1997), which is circumscribed to the south and southeast of Huelva province, small areas of Seville province, and the western litoral areas of Cadiz province. This sector is bioclimatologically considered within the thermomediterranean dry to subhumid level (Valle et al. 2004). The Aznalcázar plot shows the following characteristics: altitude 60 m a.s.l., bioclimate oceanic lustrational, thermotype thermomediterranean superior (annual mean temperature 17°-17,9° C), and ombrotype dry (annual mean rainfall 504,5-597,6 mm) [Valle et al. 2004].

Previous mycological contributions from these localities include two new species — *Coprinus alcobae* A. Ortega (Ortega & Esteve-Raventós 2003) and *Mycena dunicola* Esteve-Rav., Barrasa, M. Villarreal & A. Ortega (2001) — and additions to the genera *Macrolepiota* Singer by Migliozi & Ortega (2001), and *Amanita* Pers. by Ortega & Contú (2003).

Materials and Methods

All collections were gathered in Aznalcázar (Seville, Spain) within an approximately 3km² plot in Aznalcázar pine woodlands, along the road from Aznalcázar to Isla Mayor (km 5). The material, deposited at GDA, was collected by A. Ortega and L. Alcoba. Abbreviations of authors follow Kirk & Ansell (1992). We organized the catalogue according to the classification in Kirk et al. (2001).

Results

The checklist produced by the 2000-2002 research can be downloaded from Mycotaxon's website at <http://www.mycotaxon.com/resources/weblists.html>

Many species in the list are typically mediterranean in ecological behaviour and distribution but have been rarely recorded previously from either Spain or Portugal. Outstanding taxa include *Agaricus gennadii* (Chatin & Boud.) P.D. Orton, *Amanita boudieri* Barla, *A. curtipes* E.-J. Gilbert, *A. verna* var. *decipiens* Trimbach, *Clitocybe fontqueri* R. Heim, *Contumyces vesuviana* (V. Brig.) Redhead, Moncalvo, Vilgalys & Lutzoni, *Cortinarius scobinaceus* Malençon & Bertault, *Entoloma cistophilum* Trimbach, *E. philocistus* Hauskn. & Noordel., *Gymnopus dryophilus* var. *lanipes* (Malençon) A. Ortega, Antonín & Esteve-Rav., *Hebeloma cistophilum* Maire, *H. cylindrosporum* Romagn., *Leucoagaricus melanotrichus* (Malençon & Bertault) Trimbach, *Macrolepiota fuligineosquarrosa* Malençon, *M. phaeodisca* Bellú, *Marasmius quercophilus* Pouzar, *Torrendia pulchella* Bres., *Scleroderma meridionale* Demoulin & Malençon, *Polyporus meridionalis* (A. David) H. Jahn, *Lactarius cistophilus* Bon & Trimbach, *Russula seperina* var. *luteovirens* Bertault & Malençon, and *R. tyrrhenica* Sarnari.

The three most taxonomically interesting species include 1) *Coprinus alcobae* (Ortega & Esteve-Raventós 2003), which grows on plant debris in sandy soils and has long



outstanding rhizomorphs and very characteristic spore morphology; 2) *Mycena dunicola* (Esteve-Raventós et al. 2001), growing in sandy soils with “hygrocyboid” habit, greenish tinges of basidiomata and characteristic cystidia, and 3) *Gymnopilus arenophilus* A. Ortega & Esteve-Rav. (Ortega & Esteve-Raventós 2005) with arenophilous habitat and large spores, which may have been previously misidentified by mediterranean mycologists as *G. fulgens* (J. Favre & Maire) Singer.

Acknowledgements

We thank the “Programa de Investigación del Corredor Verde del Guadimar (Picover)” of Junta de Andalucía, for the support given through “agreement no. 12”. Also to the curator at GDA (Dr. E. Linares-Cuesta), for his help in supplying us collections. Also to Drs. G. Zervakis and A. Hausknecht for reviewing the manuscript.

Literature Cited

- Cabezudo B, Pérez de la Torre AV, Navas P, Navas D, Gil Y. 2003. Vegetación de la cuenca del Guadimar: Bases para su conservación y restauración. In: Montes C, Arenas JM, Borja F. (eds.), Ciencia y restauración del río Guadimar: 352-368. Picover 1998-2002. Consejería de Medio Ambiente de la Junta de Andalucía.

- Esteve-Raventós F, Villarreal M, Barrasa JM, Ortega A. 2001. *Mycena dunicola*, a striking new species from the Iberian Peninsula. *Mycotaxon* 80: 307-313.
- Kirk PM, Ansell AE. 1992. Authors of Fungal Names. Index of Fungi Supplement. International Mycological Institute. C.A.B International, Oxon, U.K.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th edition. CABI Publishing, Oxon, U.K.
- Migliozzi V, Ortega A. 2001. Alcune *Macrolepiota* delle sezione *Macrospora* in ambiente mediterraneo. Descrizione de *Macrolepiota fuligineosquarrosa*, *M. fuligineosquarrosa* fo. *psammophila*, *M. excoriata* e *M. konradii*. Bolletino dell Gruppo Micologico G. Bresadola 44: 5-30.
- Ortega A. 2003. Estudio de la Micoflora (hongos superiores) de la cuenca de Guadamar. In: Montes C, Arenas JM, Borja F. (eds.), Ciencia y restauración del río Guadamar: 340-350. Picover 1998-2002. Consejería de Medio Ambiente de la Junta de Andalucía.
- Ortega A, Contú M. 2003. Sobre algunas especies interesantes del género *Amanita* sección *Vaginatae* en Andalucía. *Revista Catalana de Micologia* 25: 71-77.
- Ortega A, Esteve-Raventós F. 2003. New and interesting species of *Coprinus* from Andalusia (Southern Spain). *Nova Hedwigia* 76: 465-475.
- Ortega A, Esteve-Raventós F. 2005. A new species of *Gymnopilus* (*Cortinariaceae*) from sandy soils in *Pinus* forests. *Persoonia* (in press).
- Rivas-Martínez S, Asensi A, Díez-Garretas B, Molero J, Valle F. 1997. Biogeographical synthesis of Andalucía (southern Spain). *Journal of Biogeography* 24: 915-928.
- Valle F, Navarro FB, Jiménez N. (ed.) 2004. Modelos de Restauración Forestal. Vol. 1: Datos botánicos aplicados a la gestión del Medio Natural Andaluz: bioclimatología y biogeografía. Consejería de Medio Ambiente, Junta de Andalucía. (In press).

Xanthoparmelia viriduloumbrina, a neglected species from eastern North America

JAMES C. LENDEMER

lendemer@acnatsci.org

Lichen Herbarium, Department of Botany,

The Academy of Natural Sciences of Philadelphia

1900 Benjamin Franklin Pky., Philadelphia, PA, 19103, USA

Abstract – Material from eastern North America, previously referred to *Xanthoparmelia somloënsis*, has been known for almost 15 years to be emaculate and thus not conspecific with the type of that species. *Parmelia viriduloumbrina* is the oldest available name for this material. The new combination *Xanthoparmelia viriduloumbrina* is provided.

Following the treatment of Hale (1990), the name *Xanthoparmelia somloënsis* (Gyelnik) Hale has been widely applied to loosely adnate specimens of *Xanthoparmelia* that lack isidia and soredia, have a brown/pale underside, and contain salazinic acid in the medulla. The usage of this name for uniformly emaculate material from eastern North America has puzzled lichenologists for some time, since the presence of maculae on the upper surface was considered by Hale (1990) to be a character important for defining species and was one of the defining features of *X. somloënsis*.

Initial investigation of several European exsiccati specimens cited by Hale (1990) as representing *X. somloënsis* verified that European material possessed the conspicuous maculae that are considered characteristic for *X. somloënsis* (Hale 1990, Nash & Elix 2004). Since all of the eastern North American material examined was uniformly emaculate, it seemed probable that two taxa were involved, one with maculae from Europe and one without maculae from eastern North America. Examination of the synonymy provided by Hale (1990) for *X. somloënsis* led to the discovery of a name based on material from eastern North America. Subsequent examination of the type of this name, *Parmelia viriduloumbrina* (Gyelnik) Gyelnik (basionym *Parmelia conspersa* f. *viriduloumbrina* Gyelnik), confirmed that the material lacked maculae. The type material of *X. somloënsis* (basionym *Parmelia somloënsis* Gyelnik), collected in Hungary, was also examined and confirmed to possess conspicuous maculae on the upper surface.

The presence/absence of maculae is currently considered a species level character in *Xanthoparmelia* (Hale 1990, Nash et al. 1995). It should be noted though that the few characters used to separate the ca. 500 species of *Xanthoparmelia* have never been thoroughly evaluated with present day molecular techniques. Such studies could thus

lead to revisions in the concepts used to define species of *Xanthoparmelia* that would lessen the value of a character such as maculae and place greater emphasis on other characters. Until such a time as these studies are carried out, it seems logical that in order to reflect the biodiversity of this region to adopt the name *Parmelia viriduloumbrina* (Gyelnik) Gyelnik, for the emaculate material from eastern North America which was previously referred to *X. somloënsis*. Since the epithet "viriduloumbrina" has not been used in *Xanthoparmelia*, a new combination is required.

***Xanthoparmelia viriduloumbrina* (Gyelnik) Lendemer comb. nov.**

Parmelia conspersa forma *viridulo-umbrina* Gyelnik, Magyar Botanikai Lapok, 29: 31. 1930.

TYPE: On rocks, Gwynns Falls, Baltimore Co., Maryland, USA, 3.April.1916, C.C. Plitt s.n. (BP!, holotype).

Parmelia viridulo-umbrina Gyelnik, Fedde Repert. Spec. Nov. Reg. Veg., 29: 286. 1931.

While the circumscription of *X. somloënsis* is refined here to exclude the emaculate material from eastern North America, it is suggested that the name *Xanthoparmelia somloënsis* (Gyelnik) Hale not be removed from the checklist of North American lichens (Esslinger 1997). Since material from other regions has not been extensively studied, the species may be present in North America.

It should be noted that in the past the name *Xanthoparmelia taractica* (Krempelhuber) Hale was widely used (Hale 1979) for the material now referred to *X. viriduloumbrina*. Nash et al. (1995), however, restricted the application of *X. taractica* to a South American terricolous species with broad lobes. *Xanthoparmelia coloradoensis* (Gyelnik) Hale is also similar to *X. viriduloumbrina*, however, according to Nash & Elix (2005), that species is centrally lobulate with the lobules forming a loose mat but with the primary lobes being more tightly adnate than those of *X. viriduloumbrina*.

Acknowledgements

I wish to thank the curator of BP for loaning the type material of species reviewed here. I also thank J. A. Elix, R. C. Harris, K. Knudsen, and T. H. Nash III for providing helpful criticism and discussion. R. S. Egan and T. H. Nash III also graciously provided peer reviews.

Literature Cited

- Esslinger, T. L. 1997. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: <http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm> (First posted 1 December 1997, most recent update 2 March 2004), Fargo, North Dakota.
- Hale, M. E., Jr. 1979. How To Know The Lichens. 2nd. Edition. Wm. C. Brown Co., Dubuque, Iowa, 246 pp.
- Hale, M. E., Jr. 1990. A synopsis of the lichen genus *Xanthoparmelia* (Vainio) Hale (Ascomycotina, *Parmeliaceae*). Smithsonian Contributions to Botany 74: 1-250.
- Nash, T. H., III, and J. A. Elix. 2004. *Xanthoparmelia*. In: Nash, T. H., III, B. D. Ryan, P. Diederich, C. Gries, and F. Bungartz (eds.): Lichen Flora of the Greater Sonoran Desert Region, Vol. 2. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 566-604.
- Nash, T.H., III, C. Gries, and J.A. Elix. 1995. A Revision of the Lichen Genus *Xanthoparmelia* in South America. Bibliotheca Lichenologica 56, J. Cramer, Berlin and Stuttgart. 157 pp.

A revision of *Albugo* (Chromista, Peronosporomycetes)

MARCO THINES & OTMAR SPRING

*thines@uni-hohenheim.de, spring@uni-hohenheim.de**University of Hohenheim, Institute of Botany (210)**Garbenstr. 30 70599 Stuttgart, Germany*

Abstract—After a revision of the taxonomy and nomenclature of *Albugo*, it is concluded that this genus contains at least three groups of species that deserve generic level. Taking into account the unique features of these organisms, the subclass Albuginomycetidae and the order Albuginales are introduced. The genus *Albugo* is emended and two new genera, *Pustula* and *Wilsoniana*, are introduced for the white rusts of Asteridae and Caryophyllidae, respectively. Based on morphological, ultra structural and molecular grounds, eight new combinations are proposed: *Pustula chardiniae*, *P. hydrocotyles*, *P. tragopogonis*, *Wilsoniana achyranthis*, *W. bliti*, *W. platensis*, and *W. portulacae*.

Key words—white rust, taxonomy, SEM, ultra structure, rDNA

Introduction

The genus *Albugo* (Pers.) Roussel (1806) comprises ca. 50 species that are obligate biotrophic parasites of Dicotyledonae (Biga 1955, Choi & Priest 1995). Some species, like *Albugo occidentalis*, *A. portulacae*, *A. candida*, and *A. tragopogonis*, have economic relevance, causing diseases known as “white rusts” to various crop plants. The genus *Albugo* had first been placed in the *Protomyceae* by Gray (1821). Later, de Bary (1863) transferred *Albugo* to the *Peronosporaceae* under the generic name *Cystopus* Lév., which had been introduced by Léveillé (1847) after the sexual form of *Albugo* had been discovered. Through the use of *Cystopus* by deBary, this generic name became widespread and was adopted in the *Sylloge Fungorum* (Berlese & De Toni 1888 and proceeding volumes), and also by Wakefield (1927). Biga (1955) pointed out that the name *Albugo* was in consent with the International Code of Botanical Nomenclature, which allows the further use of *Albugo*, although the sexual form had been described under the generic name *Cystopus*.

In 1893 Schröter introduced the family *Albuginaceae* to accommodate the genus *Albugo*. The monogeneric *Albuginaceae* has traditionally been placed within the order *Peronosporales* (downy mildews) (Kirk & al. 2001, Dick 2001). However, recent molecular phylogenetic studies do not support this placement (Petersen and Rosendahl 2000, Cooke & al. 2000 and 2002, Riethmüller & al. 2002), but placed *Albugo* basal to the *Pythiales*. Moreover, Hudspeth & al. (2003) even doubted a closer relationship

between the white rusts (which were found to be basal to the *Rhipidiales* in their survey) and the downy mildews, and thus suggested that *Albugo* should be raised to ordinal level. Wolf and Wolf (1947) probably noticed the distinctness of this group as they mentioned an order *Albuginales*, but provided no description and, in addition, did not include the order in their key to the orders of the Oomycetes.

As a unique feature within the *Peronosporales*, sporangia in *Albugo* are formed basipetally in chains beneath the epidermis of the host plant, whereas in all other obligate biotrophic pathogens within the *Peronosporales*, single sporangia are formed almost simultaneously on the ultimate branchlets of sporangiophores, which emerge through the stomata of the host plant. Furthermore, the way of sexual reproduction, especially as described for the multinucleate oospore formation of *A. portulacae* and *A. bliti* (Stevens 1899, 1901, 1904), points to the unrelatedness of the white rusts and the downy mildews. The unique mode of oospore germination, producing zoospores without prior formation of a germ tube (de Bary 1863, Schröter 1893), also clearly separates *Albugo* from the rest of the *Peronosporales*.

Due to the seemingly morphological uniformity of *Albugo*, the phylogenetic studies have been mainly restricted to molecular phylogenetics, *A. candida* being the only species examined. Although characters like the structure of sporangia or oospore have been used to distinguish between species or species groups within *Albugo*, they have mostly been applied to construct identification keys (Migula 1910, Biga 1955, Choi and Priest 1995) and have not been critically evaluated as possible tools for separating monophyletic groups within *Albugo*. Other useful characters, like metabolic pathways, chemical characters or ultrastructural features, which have been brought into consideration (Hall, 1996; Spring and Thines 2004), have not yet been taken into account.

Since the studies of de Bary (1863), the presence or absence of an equatorial wall thickening of sporangia has been noticed and used to divide *Albugo* into the sections *Annulatae* and *Aequales* for species with or without equatorial wall thickening. The first section consisted of *A. tragopogonis* and *A. bliti*, the latter of the rest of *Albugo* species recognised at that time. These two sections have proven to be polyphyletic by the molecular phylogenetic analyses of Riethmüller & al. (2002), Voglmayr (pers. comm.) and our own results.

Another feature, which has been used to distinguish between groups of *Albugo* species, is the presence or the absence of a distinctive primary or terminal sporangium. Such sporangia, differing from the other sporangia in size, type of germination, colour, wall thickness and wall structure, are reported from *Albugo* parasitic on Asterids and Caryophyllids, but it was claimed that they are lacking in *Albugo* parasitic on *Brassicaceae*, where all sporangia are reported to be similar (de Bary 1863; Berlese & De Toni 1888). However, our research in progress shows that this dimorphism is encountered in all species of *Albugo*.

The aim of this work was to determine, whether the different groups of *Albugo* species, as becoming apparent after a review of the original species descriptions and notes on the oospore formation, as reviewed by Gäumann (1926) and Wolf and Wolf (1947), can be confirmed by applying light and scanning electron microscopy as well as molecular phylogenetic analysis. Furthermore, it aims at providing a more natural taxonomy for the species presently placed in the genus *Albugo* and points out the uniqueness of the

three major groups described, encouraging future exploration and phylogenetic research in these organisms. Two new genera are described, *Pustula* Thines for the white rusts of Asterids and *Wilsoniana* Thines for the white rust of Caryophyllids. New combinations were only proposed for taxa examined with scanning electron microscopy (SEM) and light microscopy (LM). However, it seems very likely that many species remaining in *Albugo* s.str., which are parasitic on plants closely related to the host of the type species of one of the new genera, could be assigned to those, and that even more species groups, which might warrant generic level, are present in *Albugo* s.l..

Material and Methods

Scanning electron microscopy (SEM)

About half of a square centimetre of infected plant material, containing at least two pustules, was taken from herbarium vouchers and desiccated over silica gel in a desiccator. Afterwards, the samples were mounted on aluminium object holders using carbon layers and sputtered for eight minutes in a sputtering device (Balzer Union, Germany) with an alloy of gold : palladium 80:20. Samples were examined using a Zeiss DSM 940 (Zeiss, Germany) scanning electron microscope.

Light microscopy

Sporangia were collected from at least two pustules of the specimens. Turgidity was partly restored by heating the sporangia in water for 10 min. The sporangia were subsequently transferred to microscopic slides and analysed using a Zeiss Axioplan (Zeiss, Germany) and a Leica Biomed (Leica, Germany) microscope.

DNA extraction, PCR, sequencing and data analysis

Sporangia from one or two pustules were subjected to DNA extraction according to the method described in May and Ristaino (2004) and modified using chloroform : isoamyl-alcohol 24:1 instead of phenol : chloroform : isoamyl-alcohol 25:24:1. PCR on the extracted DNA was performed on an Eppendorf Mastercycler (Eppendorf, Germany), using the following conditions: 30s initial denaturation at 94°C, 20s denaturation at 94°C, 20s annealing at 56°C, 40s elongation at 72°C, 30 cycles for the last three steps, followed by a final elongation for 2min at 72°C. Using these conditions, the ITS-region of *Albugo* spp. was amplified using the primers ITS1-O 5'-CGG AAG GAT CAT TAC CAC -3' (Bachofer 2004) and LR0 5'-GCT TAA GTT CAG CGG GT-3' (reverse complement to Moncalvo & al. 1995). Amplification products were analysed on 1.5% agarose gels (19.5 x 10 cm; 125 V for 90 min; ethidium bromide staining; documentation under UV 302 nm using the Easy Store system (INTAS, Germany). ITS amplicons from agarose gel separations were extracted by means of the QIAquick PCR purification Kit (Qiagen, Germany). Cycle sequencing was carried out on an automated DNA sequencer (ABI 373, Perkin Elmer) using the ABI BigDye Terminator Cycle Sequencing Kit (Perkin Elmer) and ITS-O or LR-0 primers, respectively. The sequence alignment was initially produced by means of the ClustalX (Thompson & al. 1997) software and the MegAlign and SeqMan modules of the Lasergene System (DNASar, Inc.), and visually checked and refined manually. Phylogenetic analyses were performed according to the NJ method (Saitou and Nei 1987) using MEGA software, version 2.1

(Kumar & al., Arizona, USA). The support for the internal nodes of the tree was tested with bootstrap analysis (Felsenstein 1985) using 1 000 replicates.

Plant material

For this work, about 100 samples belonging to 15 different taxa of *Albugo* were examined by LM and SEM (Table 1).

Table 1. List of specimens of *Albugo* examined

Species	Host	Origin
<i>A. achyranthis</i>	<i>Achyranthis bidentata</i>	China, Yunnan, 20 Oct. 1991
<i>A. bliti</i>	<i>Amaranthus patulus</i>	Germany, Baden, Krotzingen, July 2002 (HUH)
<i>A. bliti</i>	<i>Amaranthus retroflexus</i>	Germany, Ostfildern-Scharnhausen, 1 Sept. 2002 (HUH) * 488
<i>A. bliti</i>	<i>Amaranthus spec.</i>	Germany, Leinfelden-Echterdingen, July 2002 (HUH)
<i>A. bliti</i>	<i>Amaranthus spec.</i>	Germany, Mainz, Oppenheim, 1 Aug. 2002 (HUH)
<i>A. bliti</i>	<i>Amaranthus muricatus</i>	Uruguay, Montevideo, Migulete, 28 Feb. 1920 (HBG)
<i>A. bliti</i>	<i>Amaranthus retroflexus</i>	Germany, Bavaria, Rettenbach, Deggendorf, 25 June 1937 (BR)
<i>A. bliti</i>	<i>Amaranthus retroflexus</i>	Poland, Zaleszczyki, 25 June 1910 (BR)
<i>A. bliti</i>	<i>Amaranthus spinosus</i>	Brazil, Ceara, Quixere Co, Chapada do Apodi, 20 Nov. 2002 (UPS)
<i>A. bliti</i>	<i>Amaranthus retroflexus</i>	USA, Texas, Daton, 4 June 1902 (HBG)
<i>A. candida</i>	<i>Capsella bursa-pastoris</i>	Germany, Markgröningen, flower field, 3 Nov. 2004
<i>A. candida</i>	<i>Brassica spec.</i>	China, Yunnan, Kunming, near YAU, 26 Aug. 2004 (HUH)
<i>A. candida</i>	<i>Raphanus spec.</i>	China, Yunnan, Kunming, near YAU, 26 Aug. 2004 (HUH)
<i>A. candida</i>	<i>Capsella bursa-pastoris</i>	Germany, Ostfildern-Scharnhausen, 1 Sept. 2002 (HUH) * 505
<i>A. candida</i>	<i>Capsella bursa-pastoris</i>	Germany, Stetten, Airfield, June 2002 (HUH)
<i>A. candida</i>	<i>Sinapis arvensis</i>	Germany, Stuttgart-Obertürkheim, Uhlberg, Oct. 2002 (HUH)
<i>A. capparidearum</i>	<i>Capparis spinosa</i>	Italy, Lago di Garda, Fasano, 24 May 1912 (GZU)
<i>A. chardiniae</i>	<i>Chardinia orientalis</i>	Turkey, Ankara, 15 June 1942 (GZU) Typus
<i>A. convolvulacearum</i>	<i>Convolvulus spec.</i>	Italy, St. Catharina, Mar. 1886 (HBG)
<i>A. hydrocotyles</i>	<i>Hydrocotyle laxiflora</i>	Australia, A.C.T., Brindabella Range, 11 Jan. 1955 (GZU) Typus
<i>A. ipomoeae-aquaticae</i>	<i>Ipomoea aquatica</i>	China, Yunnan, south of Jinhong, vegetable fields, 3 Sept. 2004 (HUH) * 654
<i>A. ipomoeae-aquaticae</i>	<i>Ipomoea aquatica</i>	China, Yunnan, Jinhong, banks of the Mekong river, 2 Sept. 2004 (HUH)
<i>A. ipomoeae-panduranae</i>	<i>Jaquemontia spec.</i>	Brazil, Ceara, Limoeiro do Norte Co, 23 Nov. 2001 (UPS)
<i>A. ipomoeae-panduranae</i>	<i>Jaquemontia cf. reclinata</i>	Brasil, Copacabana, 14 Nov. 1897 (HBG)

Table 1, (*Specimens, hosts & origin*) continued

<i>A. ipomoeae-panduranae</i>	<i>Batatas edulis</i>	USA, South Carolina, Aiken, Summer 1876 (GZU)
<i>A. ipomoeae-panduranae</i>	<i>Ipomoea hederacea</i>	India, Dehli, 13 Sept. 1950 (GZU)
<i>A. ipomoeae-panduranae</i>	<i>Ipomoea purpurea</i>	USA, Alabama, Gallim, Aug. 1894 (HBG)
<i>A. ipomoeae-panduranae</i>	<i>Ipomoea reptans</i>	India, Dehli, 4 Aug. 1951 (GZU)
<i>A. ipomoeae-panduranae</i>	<i>Ipomoea spec.</i>	India, Dehli, 10 July 1950 (GZU)
<i>A. ipomoeae-panduranae</i>	<i>Ipomoea spec.</i>	Italy, St. Catharina, Mar. 1886 (HBG)
<i>A. caryophyllacearum</i>	<i>Spergularia marginata</i>	Austria, Neusiedlersee, 20 May 1952 (GZU)
<i>A. caryophyllacearum</i>	<i>Spergularia marginata</i>	Hungary, Szentágota, May 1923 (GZU)
<i>A. caryophyllacearum</i>	<i>Spergularia marginata</i>	Hungary, Szentágota, Fejer, May 1923 (GZU)
<i>A. caryophyllacearum</i>	<i>Spergularia medica</i>	Germany, Thüringen, Sulza, 1876 (HBG)
<i>A. caryophyllacearum</i>	<i>Spergularia medica</i>	Germany, Thüringen, Wenersleben, 20 May 1872 (HBG)
<i>A. caryophyllacearum</i>	<i>Spergularia salina</i>	Germany, Sylt, Westerland, 20 July 1908 (GZU)
<i>A. caryophyllacearum</i>	<i>Spergularia salina</i>	Norway, Tjømo, 24 June 1881 (HBG)
<i>A. platensis</i>	<i>Boerhaavia coccinea</i>	Brazil, Ceara, Pentecoste Co, 2 Mar. 2001 (UPS) * 680
<i>A. platensis</i>	<i>Boerhaavia diffusa</i>	India, Dehli, 28 Oct. 1950 (GZU)
<i>A. platensis</i>	<i>Boerhaavia erecta</i>	Dominican Republic, S. Domingo, Santiago, Hato del Yaque, Aug. 1931 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	China, Yunnan, south of Jinhong, vegetable fields, 3 Sept. 2004 (HUH) * 640
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Brazil, Ceara, Limoeiro do Norte Co, 15 Jan. 2001 (UPS)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Austria, Graz, Gendorf, 10 Sept. 1982 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Austria, Graz, Karl-Franzens-Universität, 4 July 2000 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Austria, Graz, Ries, Ragnitztal, 8 Aug. 1996 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Austria, Lower Austria, Altenburg, Sept. 1941 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Austria, Vienna, Südbahnhof, 3 Aug. 1998 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Canada, Toronto, 2 Sept. 1897 (HBG)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Hungary, Hantháza, Sövégháza, 8 Sept. 1903 (HBG)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Italy, Parma, Autumn 1873 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Italy, Parma, Summer 1875 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Italy, Tirol, Brixen, 16 Aug. 1904 (HBG)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	Poland, Lignitz, Sept. 1873 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	United Kingdom, Sommerset-East, 1878 (GZU)
<i>A. portulacae</i>	<i>Portulaca oleracea</i>	USA, New York, Port Byron, 23 Aug. 1893 (HBG)
<i>A. resedae</i>	<i>Reseda alba</i>	Italy, Sardinia, Sassari, Toralba, 1 May 1986 (GZU)
<i>A. spinulosus</i>	<i>Cirsium arvense</i>	Germany, Engstingen, 12 Sept. 2004 (HUH) * 636
<i>A. spinulosus</i>	<i>Cirsium arvense</i>	Germany, Bavaria, Bayreuth, 1875 (GZU)
<i>A. spinulosus</i>	<i>Cirsium arvense</i>	Germany, Bavaria, Pöcking, 9 Sept. 1978 (GZU)

Table 1, (*Specimens, hosts & origin*) continued

<i>A. spinulosus</i>	<i>Cirsium arvense</i>	Germany, Berlin, Tiergarten, 8 July 1872 (GZU)
<i>A. spinulosus</i>	<i>Cirsium arvense</i>	Germany, Saxonia, Pirna, Königsstein, July 1888, June 1890 (GZU)
<i>A. spinulosus</i>	<i>Cirsium arvense</i>	Poland, Brück, Summer 1872 (GZU)
<i>A. spinulosus</i>	<i>Cirsium oleraceum</i>	Austria, Krems, Aug. 1871 (GZU)
<i>A. spinulosus</i>	<i>Cirsium oleraceum</i>	Austria, Steiermark, Feldbach, 22 Sept. 1976 (GZU)
<i>A. spinulosus</i>	<i>Cirsium oleraceum</i>	Austria, Steiermark, Mariazell, Fadental, 8 July 2000 (GZU)
<i>A. spinulosus</i>	<i>Cirsium oleraceum</i>	Germany, Bavaria, Oberammergau, Aug. 1891 and 1892 (GZU)
<i>A. spinulosus</i>	<i>Cirsium oleraceum</i>	Germany, Saxonia, Nossen, 9 Aug. 1889 (GZU)
<i>A. spinulosus</i>	<i>Cirsium oleraceum</i>	Sweden, Halland, Tjufvadet, Aug. 1927 (GZU)
<i>A. spinulosus</i>	<i>Cirsium palustre</i>	Germany, Saxonia, Nossen, 2 Oct. 1884 (GZU)
<i>A. spinulosus</i>	<i>Cirsium spec.</i>	Germany, Thüringen, Reurieth, 12 June 1935 (GZU)
<i>A. tragopogonis</i>	<i>Ambrosia elatior</i>	Austria, Vienna, Leopoldsdorf, 27 July 1993 (GZU)
<i>A. tragopogonis</i>	<i>Artemisia biennis</i>	USA, Missouri, Madison, 1883 (HBG)
<i>A. tragopogonis</i>	<i>Centaurea scabiosa</i>	Austria, Laibach, Gamling, 4 June 1876 (HBG)
<i>A. tragopogonis</i>	<i>Centaurea scabiosa</i>	Austria, Roxalpen, Mar. 1894 (HBG)
<i>A. tragopogonis</i>	<i>Centaurea scabiosa</i>	Austria, Velbes, July 1877 (HBG)
<i>A. tragopogonis</i>	<i>Centaurea scabiosa</i>	Germany, Bavaria, Oberammergau, Aug. 1895 (GZU)
<i>A. tragopogonis</i>	<i>Centaurea scabiosa</i>	Germany, Berchtesgaden, 11 Sept. 1874 (HBG)
<i>A. tragopogonis</i>	<i>Centaurea scabiosa</i>	Germany, Murnau, Sept. 1875 (HBG)
<i>A. tragopogonis</i>	<i>Centaurea spec.</i>	Austria, Steiermark, Pleschkogl, 23 June 1974 (GZU)
<i>A. tragopogonis</i>	<i>Erigeron spec.</i>	Afghanistan, Bamian, Band-i-Amir, Lake Band-i-Zolfikar, 15 July 1962 (GZU)
<i>A. tragopogonis</i>	<i>Filagine arvense</i>	Czech Republic, Bilin, Summer 1872 (GZU)
<i>A. tragopogonis</i>	<i>Filagine germanica</i>	Danmark, Fünen, Sept. 1879 (GZU)
<i>A. tragopogonis</i>	<i>Helianthus annuus</i>	Germany, Esslingen, Oberesslingen, Champagnerstr., 10 Oct. 2004 (HUH) * 643
<i>A. tragopogonis</i>	<i>Helianthus annuus</i>	Germany, Stuttgart, Plienigen, July 2004 (HUH) * 567
<i>A. tragopogonis</i>	<i>Helianthus annuus</i>	RSA, Mar. 2003 (HUH) * 525
<i>A. tragopogonis</i>	<i>Inula britannica</i>	Czechia, Lepliz, 1872 (GZU)
<i>A. tragopogonis</i>	<i>Inula britannica</i>	Germany, Schandau, Banks of the Elbe, Aug. 1896 and Sept. 1908 (GZU)
<i>A. tragopogonis</i>	<i>Inula salicinae</i>	Italy, Parma, before 1900 (GZU)
<i>A. tragopogonis</i>	<i>Scorzonera hispanica</i>	Belgium, Brabant, Boitsfort, July 1879 (BR)
<i>A. tragopogonis</i>	<i>Scorzonera hispanica</i>	Germany, Bavaria, Bayreuth, Autumn 1875 (GZU)
<i>A. tragopogonis</i>	<i>Scorzonera hispanica</i>	Germany, Bavaria, Bayreuth, July and Aug. 1875 (GZU)
<i>A. tragopogonis</i>	<i>Scorzonera hispanica</i>	Germany, Saxonia, Nossen, July 1890 (GZU)
<i>A. tragopogonis</i>	<i>Scorzonera hispanica</i>	Russia, Petrograd, Summer 1875 (GZU)
<i>A. tragopogonis</i>	<i>Tanacetum parthenium</i>	Austria, Baden, before 1900 (GZU)

Table 1, (*Specimens, hosts & origin*) concluded

<i>A. tragopogonis</i>	<i>Tanacetum</i>	Austria, Vienna, Spring 1872 (GZU)
<i>A. tragopogonis</i>	<i>Tanacetum parthenium</i>	Danmark, Fünen, June 1878 (GZU)
<i>A. tragopogonis</i>	<i>Tanacetum parthenium</i>	Germany, Saxonia, Nossen, 31 May 1882 (GZU)
<i>A. tragopogonis</i>	<i>Tragopogon dubius</i>	Austria, Neusiedlersee, 3 June 1968 (GZU)
<i>A. tragopogonis</i>	<i>Tragopogon dubius</i>	Austria, Upper Austria, Wels, 25 Aug. 1976 (GZU)
<i>A. tragopogonis</i>	<i>Tragopogon major</i>	Poland, Aussig, Summer 1872 (GZU)
<i>A. tragopogonis</i>	<i>Tragopogon pratensis</i>	Germany, Bavaria, Bayreuth, Summer 1875 (GZU)
<i>A. tragopogonis</i>	<i>Tragopogon pratensis</i>	Germany, Saxonia, Meissen and Nossen, 25 July 1888 (GZU)

Specimens marked with an asterisk (*) have been sequenced, numbers after the asterisk give the internal handling number also found in Fig. 3; text in bold indicates type specimen vouchers.

Results and Discussion

Light and scanning electron microscopy

The observations made in light microscopy (LM) largely confirm the previously known characters of the taxa examined. Nevertheless, it is noteworthy that only species parasitic on *Hydrocotylaceae* and *Asteraceae* (Fig. 1A) have shown a distinct equatorial wall thickening in shape of a ring 7–9 µm wide and (1–)2(–3) µm thick in the central/median part. In other parts of the sporangium the wall was mostly less than 1 µm thick. The equatorial part of the wall was mostly concave. In contrast, other *Albugo* species, especially the type species, *A. candida*, did not show concave parts of the wall at or near the equator. In other species examined, the equatorial wall was, if thickened at all, mostly 50% or less thicker than in other parts of the sporangia and stretched usually over 7 µm to 12 µm, as seen in lateral view (Fig. 1C–D). In *A. candida* a variable thickening of the polar region could be observed, in contrast to the other species examined.

In scanning electron microscopy (SEM), the sporangial wall revealed various types of ornamentation (Fig. 2). In all species examined, the ornamentation, if directed, was leftwards winding. In *A. candida* the protuberances consisted of rounded warts, which were mostly forming leftwards winding lines and tended to fuse (Fig. 2D). In other species of *Albugo*, protuberances were variously shaped, ranging from warts fusing into indistinct net-like structures, to striate ornamentations consisting of elongate structures. In *Albugo* parasitic on Caryophyllidae, the sporangial wall was irregularly striate, consisting of sharp elongate, sometimes verrucose lines in *A. portulacae* (Fig. 2C) and most samples of *A. blitii* (Fig. 2B), or of small punctiform protuberances in some samples of *A. caryophyllacearum*. In *Albugo* parasitic on *Hydrocotyle laxiflora* and *Albugo* parasitic on *Asteraceae*, the sporangia showed various types of ornamentation, even within one pustule. Predominantly the sporangia revealed reticulate structures, especially in *A. tragopogonis* on *Helianthus annuus*. In samples from *A. spinulosus* on *Cirsium* spp. and *A. tragopogonis* on *Tragopogon* spp., sporangia showed mostly reticulate structures (Fig. 2A), although striate ornamentation was observed in some samples, too. In *Albugo* on *Centaurea* both reticulate and striate sporangia were present. In contrast, sporangia of *A. tragopogonis* on *Tanacetum parthenium* and

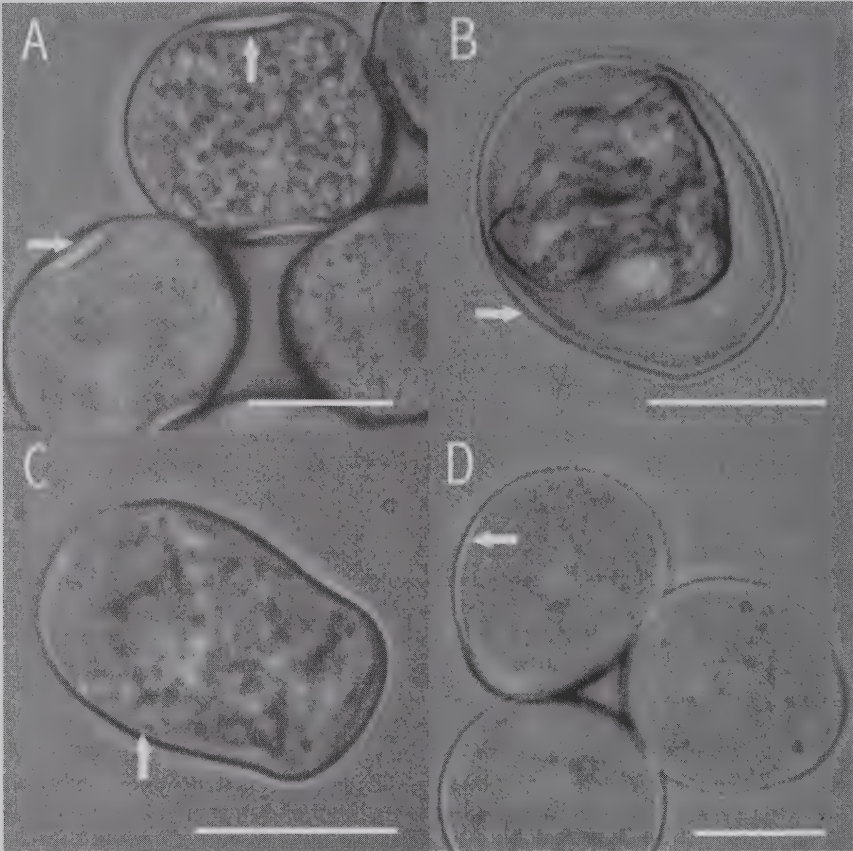


Figure 1. Sporangia of different species of *Albugo* as seen in light microscopy. A, *Albugo tragopogonis* on *Helianthus annuus*; B, *A. bliti* on *Amaranthus retroflexus*; C, *A. portulacae* on *Portulaca oleracea*; D, *A. candida* on *Capsella bursa-pastoris*. Arrows mark the equatorial part of the wall as seen in lateral view of the sporangia. Bar = 10µm in all pictures.

Artemisia biennis were striate, with only very few exceptions. In *A. chardiniae*, the type species for the new genus *Pustula* Thines, SEM revealed an irregular striate to reticulate surface ornamentation.

The morphological and ultra structural findings are summarised in Table 2.

Table 2. Comparison of the main morphological characters of *Albugo candida*, *Pustula* and *Wilsoniana*

Taxon	Equatorial wall thickening	Predominant sporangial shape	Predominant surface ornamentation
<i>Albugo candida</i>	Absent	subglobose	verrucose
<i>Wilsoniana</i>	up to 2µm	pyriform, cylindrical	verrucose, striate
<i>Pustula</i>	1.5-3.0µm	subglobose, cylindrical	striate, reticulate

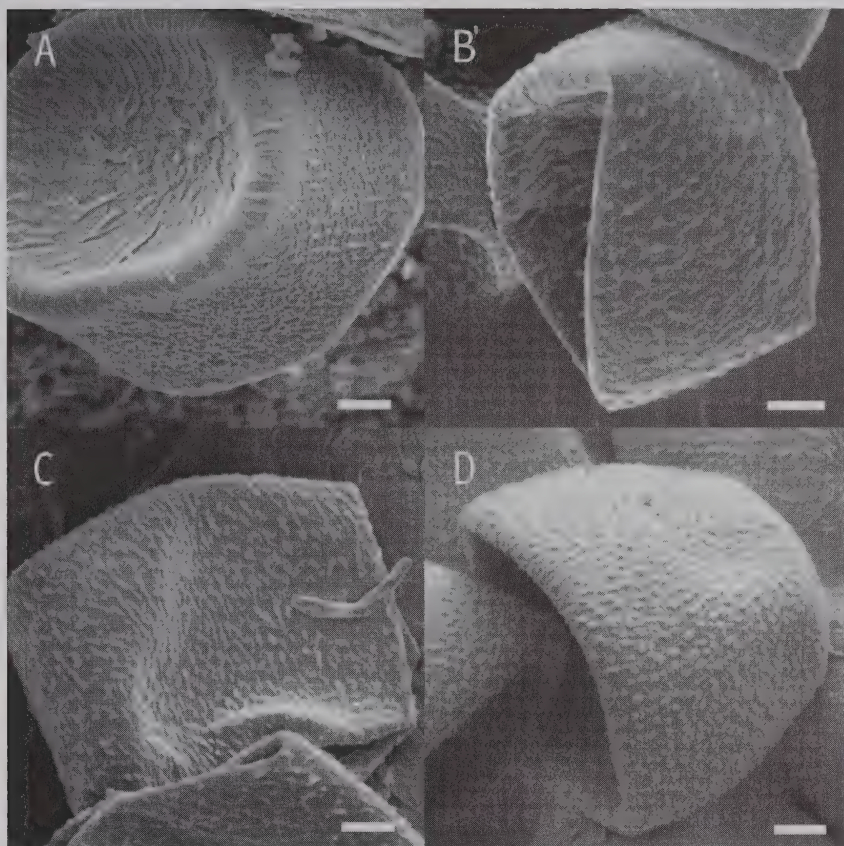


Figure 2. Ornamentation of the sporangial surface in different species of *Albugo* as seen in SEM. A, *Albugo tragopogonis* on *Tragopogon pratensis*; B, *A. bliti* on *Amaranthus retroflexus*; C, *A. portulacae* on *Portulaca oleracea*; D, *A. candida* on *Capsella bursa-pastoris*. Note that the collapsing pattern of the sporangia reflects the mode of wall thickening, as parts of the wall which are not thickened collapse first. Bar = 2 μ m in all pictures.

PCR and ITS sequencing

ITS was shortest in *Wilsoniana*, with about 720bp, followed by about 800bp in *P. tragopogonis* and about 840bp in *A. ipomoeae-aquaticae* and *A. candida*. This is consistent with the three major groupings outlined above. Sequence analyses of partial ITS of *Albugo* confirmed the results established on the basis of other genomic regions by Riethmüller & al. (2002), Hudspeth et al. (2003) and recent findings of Voglmayr (pers. comm.). The distant position of *Albugo* to other *Peronosporales* became first apparent in the studies of Petersen and Rosendahl (2000), where *Albugo* occupies a basal position to *Pythium* and *Lagenidium*. Cooke & al. 2000 also placed *Albugo* basal and distant to the *Pythiales* and *Peronosporales*. In Riethmüller & al. (2002), these findings were extended showing a division of *Albugo* into three highly supported

groups, which are consistent with the morphological and ultra structural observations of the current survey. In contrast to the results of Riethmüller & al. (2002), Hudspeth & al. (2003) found *Albugo* even further distant, placing it basal to the *Rhipidiales* of the Rhipidiomycetidae (Dick 2001). The degree of sequence variation points both to the high evolutionary rate in *Albugo* and to the unrelatedness of the three groupings found in *Albugo* s.l., in comparison to each other (Fig. 3).

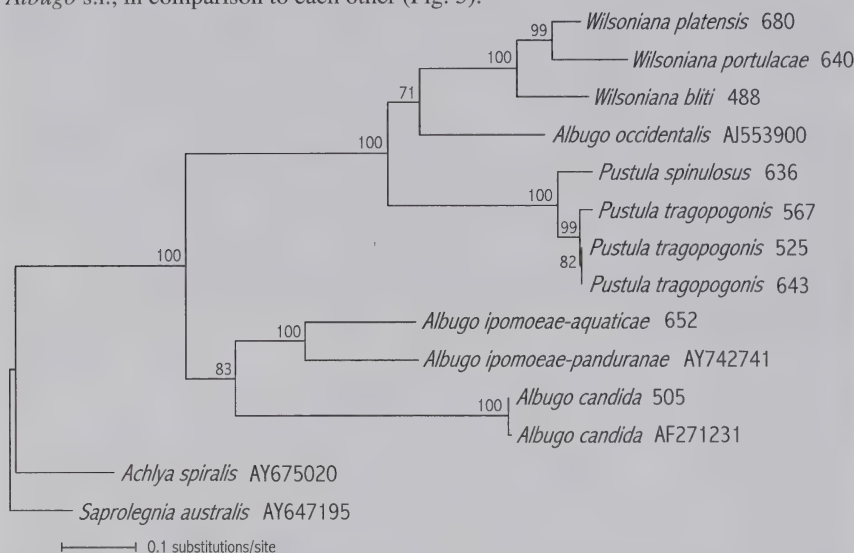


Figure 3. Phylogenetic tree according to neighbour-joining analysis of an alignment of partial ITS sequence data of selected taxa sequenced in this study and sequence data from GenBank. Accession numbers or three digit internal handling numbers are given following the species name. Tree topology was rooted with *Saprolegnia australis* sequence. Figures on branches are bootstrap values (1000 replicates). *Albugo occidentalis* which was found basal to *Wilsoniana* has not been transferred to this genus because no specimens were examined with LM or SEM.

Conclusions and taxonomic implications

The organisms presently included in *Albuginaceae* deserve to be placed in an order and a subclass of their own, due to their unique mode of sporangiogenesis, structural differences of the sporangiophores and oospores (de Bary 1863, Schröter 1893, Wilson 1907), apparent differences in their sexual life-cycle (Stevens 1899, 1901, 1904, Davis 1900, 1904, Ruhland 1903, Krüger 1910, Kin 1929), as well as evident differences in LSU, ITS and CoxII sequences (Cooke & al. 2000, Petersen & Rosendahl 2000, Riethmüller & al. 2002, Hudspeth & al. 2003). Furthermore, the genus *Albugo*, as now understood, contains at least three distinct groups which warrant generic rank.

In the following, a new taxonomic hierarchy is proposed, descriptions of a new subclass, one new order and three new genera are provided, and 8 new combinations are made. The kingdom Chromista (for references see Cavalier-Smith 1986) is adopted for the introduction of the new taxa below, because recent findings support the monophyly of the Chromista and the view that plastids were acquired before the formation of the

straminipilous flagellum (Yoon et al. 2002, Bhattacharya & al. 2003, Harper & Keeling 2003, Keeling 2004). Also the presence of genes typical for autotrophic organisms in *Phytophthora* (Andersson & Roger 2002) supports this view. Therefore the kingdom Straminipila is abandoned in favour of the larger, previously described kingdom Chromista.

Albuginomycetidae Thines

Albuginales Thines

Albuginaceae J. Schröt.

Albugo (Pers.) Roussel

Pustula Thines

Wilsoniana Thines

Albuginomycetidae Thines, subclassis nova

Chromista, Peronosporomycetes. Hyphae intercellulares; haustoria intracellularia, plerumque parva globosa. Sporangiphora hyalina, fasciculis in sori aggregata, simplices, leves, cylindracea vel clavata, singula apica sporangiorum seriem moniliformem gerentes. Sori epidermide planta nutricis candidi vel lutescentes, primo tecti, dein epidermidem dirumpentes et sporangia matura dispergentes. Sporangia irregularia, conformibus et hyalina aut difformibus, sporangia hyalina solita zoosporipara, sporangia luteola solita sterilia. Oogonia globosa vel irregularia, brunneola. Oosporae globosae, luteolae vel brunneae, zoosporipara.

Typus: *Albugo* (Pers.) Roussel, Flore du Calvados, 2^e Ed. : 30 (1806)

Chromista, Peronosporomycetes. Hyphae intercellular; haustoria intracellular, small, mostly globose vesicles. Sori formed beneath the epidermis of the host plant, white to yellowish, first covered by the epidermis of the host plant. Powdery mass of mature sporangia dispersed through ruptured epidermis of the host plant. Sporangiphores colourless, agglomerated in large fascicles or sori, unbranched, clavate to cylindrical. Sporangia produced basipetally, in chains, at the top of the sporangiophore. Sporangia variously shaped, either of one type, colourless, on germination usually producing zoospores, or a second type, yellowish, usually sterile, also present. Oogonia globose to irregular, oospores globose, yellowish to brownish, producing zoospores on germination.

Albuginales Thines, ordo nov.

= *Albuginales* nom. nud., F.A. Wolf & F.T. Wolf, The Fungi, Vol. I, 105-108 (1947)

Chromista, Peronosporomycetes. Hyphae intercellulares; haustoria intracellularia, plerumque parva globosa. Sporangiphora hyalina, fasciculis in sori aggregata, simplices, leves, cylindracea vel clavata, singula apica sporangiorum seriem moniliformem gerentes. Sori epidermide planta nutricis candidi vel lutescentes, primo tecti, dein epidermidem dirumpentes et sporangia matura dispergentes. Sporangia irregularia, conformibus et hyalina aut difformibus, sporangia hyalina solita zoosporipara, sporangia luteola solita sterilia. Oogonia globosa vel irregularia, brunneola. Oosporae globosae, luteolae vel brunneae, zoosporipara.

Typus: *Albugo* (Pers.) Roussel, Flore du Calvados, 2^e Ed. : 30 (1806)

Chromista, Peronosporomycetes. Hyphae intercellular; haustoria intracellular, small, mostly globose vesicles. Sori formed beneath the epidermis of the host plant, white to yellowish, first covered by the epidermis of the host plant. Powdery mass of mature sporangia dispersed through ruptured epidermis of the host plant. Sporangiphores colourless, agglomerated in large fascicles or sori, unbranched, clavate to cylindrical. Sporangia produced basipetally, in chains, at the top of the sporangiophore. Sporangia variously shaped, either of one type, colourless, on germination usually producing zoospores, or a second type, yellowish, usually sterile, also present. Oogonia globose to irregular, oospores globose, yellowish to brownish, producing zoospores on germination.

Albuginaceae J. Schröt., Nat. Pflanzenfamilien 1(1): 110 (1893)

Typus: Albugo (Pers.) Roussel, Flore du Calvados, 2^e Ed. : 30 (1806)

Albugo (Pers.) Roussel, **emend.**

Chromista, Albuginales. Hyphae intercellulares; haustoria intracellularia, plerumque parva globosa. Sporangiphora hyalina, fasciculis in sori aggregata, simplices, leves, cylindracea vel clavata, singula apica sporangiorum seriem moniliformem gerentes. Sori epidermide planta nutricis candidi vel lutescentes, primo tecti, dein epidermen dirumpentes et sporangia matura dispergentes. Sporangia primo formis ceteris similis, sporangia hyalina, globosa vel subglobosa, verrucosa, paries circumcirca aequalis vel paries aequatorialis incrassatis modestis, plerumque zoosporipara. Oogonia globosa vel irregularia, brunneola. Oosporae globosae, luteolae vel brunneae, zoosporipara.

Species typica: Albugo candida (Pers.) Roussel, Flore du Calvados, 2^e Ed. : 41 (1806)

Chromista, *Albuginales*. Hyphae intercellular; haustoria intracellular, small, mostly globose vesicles. Sori formed beneath the epidermis of the host plant, white to yellowish, first covered by the epidermis of the host plant. Mature sporangia dispersed through ruptured epidermis of the host plant. Sporangiphores colourless, agglomerated in large fascicles or sori, unbranched, clavate to cylindrical. Sporangia produced basipetally, in chains, at the top of the sporangiophore. Sporangia first formed similar to the others, in contrast to *Wilsoniana* and *Pustula*, sporangia colourless, globose to subglobose, wall of uniform thickness, or slightly thickened in the equatorial part, commonly forming a broad annulus, in contrast to *Pustula*, where the annulus is usually thicker and narrow; surface appearing verrucose in scanning electron microscopy, the warts forming lined to reticulate structures; on germination usually producing zoospores. Oogonia globose to irregular; oospores globose, yellowish to brownish, on germination producing zoospores.

Pustula Thines, **gen. nov.**

Chromista, Albuginales. Hyphae intercellulares; haustoria intracellularia, plerumque parva globosa. Sporangiphora hyalina, fasciculis in sori aggregata, simplices, leves, cylindracea vel clavata, singula apica sporangiorum seriem moniliformem gerentes. Sori epidermide planta nutricis candidi vel lutescentes, primo tecti, dein epidermidem dirumpentes et sporangia matura dispergentes. Sporangia difformibus, sporangia primo formis ceteris plerumque majoribus, lutescentes, depresso globosa, sterilibus, paries valde crassa, ceteris hyalina, subglobosa vel cylindracea, reticulata vel striata,

plerumque zoosporipara, paries aequatorialis incrassatis munitis. Oogonia globosa vel irregularia, brunneola. Oosporae globosae, luteolae vel brunneae, zoosporipara.

Species typica: *Pustula chardiniae* (Bremer & Petr.) Thines

Etymology: From Latin *pustula* (blister)

Chromista, *Albuginales*. Hyphae intercellular; haustoria intracellular, small, mostly globose vesicles. Sori formed beneath the epidermis of the host plant, white to yellowish, first covered by the epidermis of the host plant. Mature sporangia dispersed through ruptured epidermis of the host plant. Sporangiphores colourless, agglomerated in large fascicles or sori, unbranched, clavate to cylindrical. Sporangia produced basipetally, in chains, at the top of the sporangiphore. Sporangia of two types, the first produced yellowish, mostly larger, sterile with an overall thickened wall, in contrast to *Albugo*; the subsequent sporangia are colourless, subglobose to cylindrical, wall surface appears reticulate to striate in scanning electron microscopy, in contrast to *Wilsoniana*, where the surface ornamentation is never reticulate; equatorial part of the wall significantly thickened, the annulus usually narrow, in contrast to *Albugo* and *Wilsoniana*; on germination commonly producing zoospores. Oogonia globose to irregular, oospores globose, yellowish to brownish, on germination producing zoospores.

New combinations:

Pustula chardiniae (Bremer & Petr.) Thines, **comb. nov**

Basionym: *Albugo chardiniae* Bremer & Petr., Sydowia 2(1): 248 (1947)

Pustula hydrocotyles (Petr.) Thines, **comb. nov.**

Basionym: *Albugo hydrocotyles* Petr., Sydowia 9: 559 (1955)

Pustula spinulosa (de Bary) Thines, **comb. nov.**

Basionym: *Cystopus spinulosus* de Bary, Ann. Sci. Nat., ser. 4, 20:133 (1862)

Replaced synonym: *Albugo spinulosus* (de Bary) Kuntze, Revis. gen. pl. (Leipzig) 2: 658 (1891)

Pustula tragopogonis (Pers.) Thines, **comb. nov.**

Basionym: *Uredo candida* f. *tragopogi* Pers., Syn., Meth. Fung. p. 223 (1801)

Replaced synonym: *Albugo tragopogonis* (Pers.) Gray, Nat. Arr. Brit. Pl. (London) 1: 540 (1821)

Wilsoniana Thines, **gen. nov.**

Chromista, Albuginales. Hyphae intercellulares; haustoria intracellularea, plerumque parva globosa. Sporangiphora hyalina, fasciculis in sori aggregata, simplices, leves, cylindracea vel clavata, singula apica sporangiorum seriem moniliformem gerentes. Sori epidermide planta nutricis candidi vel lutescentes, primo tecti, dein epidermidem dirumpentes et sporangia matura dispergentes. Sporangia difformibus, terminalibus ceteris plerumque minoribus vel majoribus, lutescentes, globosa, sterilibus, paries circumcirca valde crassa, ceteris hyalina, ovoidea vel cilindrico-ovoidea vel pyriformibus, striata irregularis vel punctata irregularis, zoosporiparis, paries circumcirca aequalis vel paries aequatorialis incrassatis modestis. Oogonia globosa vel irregularia, brunneola. Oosporae globosae, luteolae vel brunneae, zoosporipara.

Species typica: *Wilsoniana portulacae* (DC. ex Duby) Thines

Etymology: Dedicated to the American mycologist G. W. Wilson.

Chromista, *Albuginales*. Hyphae intercellular; haustoria intracellular, small, mostly globose vesicles. Sori formed beneath the epidermis of the host plant, white to yellowish, first covered by the epidermis of the host plant. Mature sporangia dispersed through ruptured epidermis of the host plant. Sporangiphores colourless, agglomerated in large fascicles or sori, unbranched, clavate to cylindrical. Sporangia produced basipetally, in chains, at the top of the sporangiphore. Sporangia of two types, the terminal ones yellowish, smaller or larger than the subsequent, with overall thickened wall, usually sterile, in contrast to *Albugo*, the others colourless, ovoid to cylindrical ovoid to pyriform in contrast to *Pustula*, where pyriform sporangia are usually not present; surface wall irregular striate to punctate, as seen in scanning electron microscopy. The wall of sporangia either uniformly thick, or the wall is thickened to a moderate degree in the equatorial part, the annulus usually broad; on germination commonly produce zoospores. Oogonia globose to irregular shaped, oospores globose, yellowish to brownish, on germination producing zoospores.

New combinations:

Wilsoniana achyranthis (Henn.) Thines, **comb. nov.**

Basionym: *Cystopus bliti* (Biv.) de Bary f. *achyranthis* Henn., Engl. Bot. Jahrb. 28:259 (1901).

Replaced synonym: *Albugo achyranthis* (Henn.) Miyabe, Trans. Sapporo nat. Hist. Soc. 14(1): no. 19 (1935).

Wilsoniana bliti (Biv.) Thines, **comb. nov.**

Basionym: *Uredo bliti* Biv., Stirp. rar. Sicilia 3: 11 (1815).

Replaced synonym: *Albugo bliti* (Biv.) Kuntze, Revis. gen. pl. (Leipzig) 2: 658 (1891).

Wilsoniana platensis (Speg.) Thines, **comb. nov.**

Basionym: *Cystopus platensis* Speg., Rev. Arg. Hist. Nat. 1: 32 (1891).

Replaced synonym: *Albugo platensis* (Speg.) Swingle, J. Mycol. 7(2): 113 (1894).

Wilsoniana portulacae (DC. ex Duby) Thines **comb. nov.**

Basionym: *Uredo portulacae* DC., Fl. France 5: 88 (1815).

Replaced synonym: *Albugo portulacae* (DC. ex Duby) Kuntze, Revis. gen. pl. (Leipzig) 2: 658 (1891).

Albugo caryophyllacearum (Wallr.) Cif. & Biga was excluded from the new combinations because of significant differences in oospore development, as described by Ruhland 1903, although the morphological characters suggest that this species should be transferred to *Wilsoniana*. For further notes on the synonyms see Wilson (1907) and Biga (1955).

Acknowledgements

This work was partly financed by the Ministry of Education, Research and Arts of Baden-Württemberg. We wish to thank Dr. A. Heller for providing the access to the SEM of the Institute of Botany and Christa Lanz, Tübingen, Germany for sequencing support. We are indebted to the curators of the Herbaria BR, GZU, HBG and UPS for providing us the access to the specimens in their keeping. Cordial thanks to Ovidiu Constantinescu for providing some specimens and also, along with Ferenc Viranyi, for kindly reviewing the manuscript.

Literature cited

- Andersson JO, Roger AJ. 2002. A cyanobacterial gene in nonphotosynthetic protists – an early chloroplast acquisition in eukaryotes? *Curr. Biol.* 12: 115-119.
- Bachofer M. 2004. Molekularbiologische Populationsstudien an *Plasmopara halstedii*, dem Falschen Mehltau der Sonnenblume. Dissertation, Universität Hohenheim, Germany.
- Bary, A. de 1863. Recherches sur le développement de quelques champignons parasites. *Ann. Sci. Nat. Bot.*, Sér. 4. 20: 5-148.
- Berlese AN, de Toni JB. 1888. Phycomycetae. In: *Sylloge Fungorum* (Ed. Saccardo PA). 7(1): 181-322
- Bhattacharya D, Yoon HS, Hackett JD. 2003. Photosynthetic eukaryotes unite: endosymbiosis connects the dots. *BioEssays* 26: 50-60.
- Biga BML. 1955. Riesaminazione delle specie del genere *Albugo* in base alla morfologia dei conidi. *Sydowia* 9: 339-358.
- Cavalier-Smith T. 1986. The kingdom Chromista: origin and systematics. In: *Progress in Phycological research* Vol. 4 (Round FE, Chapman DJ eds.). Biopress Limited, Bristol, UK 309-347.
- Choi D, Priest MJ. 1995. A key to the genus *Albugo*. *Mycotaxon* 53: 261-272.
- Cooke DEL, Drenth A, Duncan JM, Wagels G, Brasier CM. 2000. A molecular phylogeny of *Phytophthora* and related Oomycetes. *Fungal Genet. Biol.* 30: 17-32.
- Cooke DEL, Williams NA., Williamson B, Duncan JM. 2002. An ITS-based phylogenetic analysis of the relationships between *Peronospora* and *Phytophthora*. In *Advances in Downy Mildew Research*. (Eds Spencer-Phillips PTN, Gisi U, Lebeda A) 1: 161-165. Kluwer, Dordrecht / Boston /London.
- Davis BM. 1900. The fertilisation of *Albugo candida*. *Bot. Gaz.* 29: 297-311.
- Davis BM. 1904. The relationships of sexual organs in plants. *Bot. Gaz.* 38: 241-264.
- Dick MW. 2001. *Straminipilous Fungi*. Kluwer, Dordrecht /Boston /London.
- Felsenstein J. 1985. Confidence limits on phylogenies: an approach using bootstrap. *Evolution* 39: 783-791.
- Gray SF. 1821. *Natural Arrangement of British Plants*. London, 1: 540.
- Hall G. 1996. Modern approaches to species concepts in downy mildews. *Pl. Pathol.* 45: 1009-1026.
- Harper JT, Keeling PJ. 2003. Nucleus-encoded, plastid-targeted glyceraldehydes-3-phosphate dehydrogenase (GAPDH) indicates a single origin for chromalveolate plastids. *Mol. Biol. Evol.* 20: 1730-1735.
- Hudspeth DS, Stenger, DC, Hudspeth, ME. 2003. A Cox2 Phylogenetic hypothesis for the downy mildews and white rusts. *Fungal Diversity* 13: 47-57.
- Keeling P. 2004. A brief history of plastids and their hosts. *Protist* 155: 3-7.
- Kirk PM, Cannon PF, David JC, Stalpers JA (eds) 2001. *Ainsworth and Bisby's Dictionary of Fungi*. 9th Ed., CABI Publishing, UK.
- Krüger F. 1910. Beitrag zur Kenntnis der Kernverhältnisse von *Albugo candida* etc. *Centralbl. Bact.* 27: 186-205.
- Léveillé J-H. 1847. Sur la disposition methodique des Uredinées. *Ann. Sci. Nat. Bot.* Sér. 3, 8: 369-376.
- May KJ, Ristaino JB. 2004. Identity of the mtDNA haplotypes of *Phytophthora infestans* in historical specimens from the Irish Potato Famine. *Micol. Res.* 108: 471-479.
- Migula W. 1910. Familie Albuginaceae. In: *Kryptogamen-Flora von Deutschland, Deutsch-Österreich und der Schweiz*. 3, Pilze (1): 153-155. Hugo Bermühler, Berlin.

- Moncalvo JM, Wang HH, Hseu RS. 1995. Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. *Mycologia* 87: 223-238.
- Petersen AB, Rosendahl S. 2000. Phylogeny of the Peronosporomycetes (Oomycota) based on partial sequences of the large ribosomal subunit (LSU rDNA). *Mycol. Res.* 104: 1295-1303.
- Riethmüller A, Voglmayr H, Göker M, Weiß M, Oberwinkler F. 2002. Phylogenetic relationships of the downy mildews (*Peronosporales*) and related groups based on nuclear large subunit ribosomal DNA sequences. *Mycologia* 94: 834-849.
- Roussel HFA de. 1806. *Flore du Calvados*. 2^e Ed., Caen, France.
- Ruhland W. 1904. Studien über die Befruchtung der *Albugo lepigoni* etc. *Jahrb. Wiss. Bot.* 39: 135-166.
- Saitou N, Nei M. 1987. The neighbour-joining method: a new method for reconstructing phylogenetic trees. *Molec. Biol. Evol.* 4: 406-425.
- Schröter J. 1893. Peronosporinae. In: *Die natürlichen Pflanzenfamilien* (Ed. Engler A.). Wilhelm Engelmann, Leipzig. 1: 108-119.
- Spring O, Thines M. 2004. On the necessity of new characters for classification and systematics of biotrophic Peronosporomycetes. *Planta* 219: 910-914.
- Stevens FL. 1899. The compound oosphere of *Albugo bliti*. *Bot. Gaz.* 28: 149-176.
- Stevens FL. 1901. Gametogenesis and fertilization in *Albugo*. I-III. *Bot. Gaz.* 32: 77-98; 157-169; 238-261.
- Stevens FL. 1904. Oogenesis and fertilization in *Albugo ipomoeae-panduranae*. *Bot. Gaz.* 38: 300-302.
- Thompson JN, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG (1997) The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucl. Acid Res.* 25: 4876-4882.
- Wakefield EM, 1927. The genus *Cystopus* in South Africa. *Bothalia* 2: 242-246.
- Wilson GW. 1907. Studies in North American *Peronosporales* I, The genus *Albugo*. *Bull. Torrey Bot. Club.* 34:61-84.
- Wolf FA, Wolf FT. 1947. *The Fungi*. John Wiley and Sons, New York. Vol. I.
- Yoon HS, Hackett JD, Pinto G, Bhattacharya D. 2002. A single, ancient origin of the plastid in the Chromista. *Poc. Natl. Acad. Sci. USA* 99: 15507-15512.

***Apiognomonina fakirovae* sp. nov. (Diaporthales)
on *Quercus cerris* (Fagaceae)**

DIMITAR Y. STOYKOV

stoikov@bio.bas.bg

Institute of Botany, Bulgarian Academy of Sciences

23 Acad. G. Bonchev Str., BG-1113 Sofia, Bulgaria

Abstract—A new species, *Apiognomonina fakirovae* is described and illustrated. The species was collected on overwintered leaves of *Quercus cerris* from Bulgaria.

Key words—ascomycetes, Bulgaria, taxonomy, *Valsaceae*

The genus *Apiognomonina* Höhn. (*Valsaceae*) contains altogether about 20 species (Barr 1978, 1991; Monod 1983, 1984; Kaneko & Kobayashi 1984; Merezhko & Smyk 1991). The main distinguishing features of this genus are nonstromatic, upright, depressed globose perithecia with papillar or conic to elongate, central or eccentric beak, immersed in the tissues of substrata. The ascospores are hyaline, narrowly ellipsoid or fusoid, usually inequilateral, with a nonmedian (apiosporous) single septum, which gives inequality of the two cells of the spores.

During routine collections from Sredna Gora Mt region, a species of *Apiognomonina* on overwintered leaves of European Turkey oak was obtained. Monod (1983) and Kaneko and Kobayashi (1984) indicate 3 different species: *Apiognomonina errabunda* (Roberge) Höhn., *A. suprasedata* S. Kaneko & Tak. Kobayashi — recorded on *Quercus* leaves, and *A. veneta* (Sacc. & Speg.) Höhn. — known on leaves of *Platanus*, related to our finding. However, the species collected from Bulgaria is easily distinguished from these three species on the basis of perithecia, beak, asci, ascospores and host species (Figs 1–2, Table 1). As a result, a new species is proposed herein.

***Apiognomonina fakirovae* Stoykov, sp. nov.**

Fig. 1

Sine stroma. Perithecia 240–290 × 330–350 µm diametro, nigra, immersa, recta, globosa vel depressa globosa, singularia. *Peridium* compositum brunnei cellulis prismaticis (12–)13–15(–16.5) µm. *Rostrum* (270–)300–450 × 25–50(–60) µm, centrale, raro excentricis, rectum vel leviter curvatum, atra, leviter latae et albidus vel non coloratus ad extremum, erumpentis, epiphyllus. *Asci* 19–28 × 5.5–10 µm, numerosae, ellipsoideae vel fusiformes, continentes 8 spores cum annulo apicali 1.5 µm. *Ascosporae* (7.5–) 8.38 ± 0.76 (–10) × (2–) 2.16 ± 0.11 (–2.2) µm (n = 50), hyalinae, ellipsoideae vel angustae fusoidae, rectae vel leviter curvatae, apiosporae, prope basim ca. 1/4 longitudinae, 1-septatae, ad septum non constrictae, irregulariter biseriales, sine appendicibus. Magna cellula in asco annulo apicalem versus, sine guttulas.

Table 1. Taxonomic features of *Apiognomonina errabunda*, *A. fukirovae*, *A. supraseptata* and *A. veneta*

Species	Perithecia	Beak	Asci	Ascospores	Host
<i>A. errabunda</i>	150–200 μm in diam., immersed in leaf, nerves and petioles	100–200 x 30–50 μm , central, straight	36–48 x 7.5–10 μm , apical ring 3 μm	12.5–15 x 2.5–4 μm , septum at 1/6 of the length; bigger cell with 2 large or many small guttules	<i>Quercus</i> , <i>Fagus</i> , <i>Tilia</i> , <i>etc.</i>
<i>A. fukirovae</i>	240–290 x 330–350 μm , immersed in leaf tissues	(270–) 300–450 x 25–50 (–60) μm , central, straight or little curved, epiphyllous	19–28 x 5.5–10 μm , broadly ellipsoidal to fusoid, apical ring ca. 1.5 μm	7.5–10 x 2–2.2 μm ; ellipsoid-fusoid, straight or little curved; septum at 1/4 of the length, without guttules	<i>Q. cerris</i>
<i>A. supraseptata</i>	130–220 x 80–180 μm in diam., globose or depressed globose, immersed in lesions of the leaves	300 x 50–75 μm , central, rarely eccentric, mostly hypophyllous	52–70 x 10–12.5 μm (mostly 63 x 11.3 μm), clavate to cylindric-clavate	11–15 x 4.5–6 μm (mostly 13.2 x 5.3 μm), ellipsoid, septate near the apex, constricted at the septum	<i>Q. glauca</i>
<i>A. veneta</i>	170–250 μm in diam., darkened, immersed in leaves	90–170 x 40–50 μm , central, straight	42–57 x 7.5–11 μm , apical ring 3 μm	13.5–15 x 3–4.5 μm , septum at 1/6 of the length, without appendage	<i>Platanus</i> spp.

Holotypus hic designatus: *Ad folia emortui Querci cerris, Bulgaria, Mons Sredna Gora occidentalis, Mons Lozenska Planina, supra pagum Novi Han, in loco dicto 'Petschurkata', 31.V.2000, D.Y. Stoykov, SOMF 24215.*

Etymology: Named in honour of Dr Violeta Fakirova (1936-2004) (cfr Denchev 2005).

Perithecia 240–290 × 330–350 μm , black, immersed, upright, globose or depressed globose, single. **Peridium** composed of brownish prismatic cells (12–)13–15(–16.5) μm . **Beak** (270–)300–450 × 25–50(–60) μm , central or eccentric, straight to slightly curved, black, slightly wider and colourless at the apex, erumpent, epiphyllous. **Asci** 19–28 × 5.5–10 μm , numerous, broadly ellipsoid to fusoid, 8-spored, with apical ring 1.5 μm . **Ascospores** (7.5–) 8.38 ± 0.76 (–10) × (2–) 2.16 ± 0.11 (–2.2) μm (n = 50), hyaline, ellipsoid or narrowly fusoid, straight to little curved, apiosporous (septum at 1/4 of the length), not constricted at the septum, irregularly biseriata, without appendage. The bigger cell oriented towards the apical annulus in the ascus, without guttules.

On overwintered leaves of *Quercus cerris* L.

Distribution: known only from the type locality.

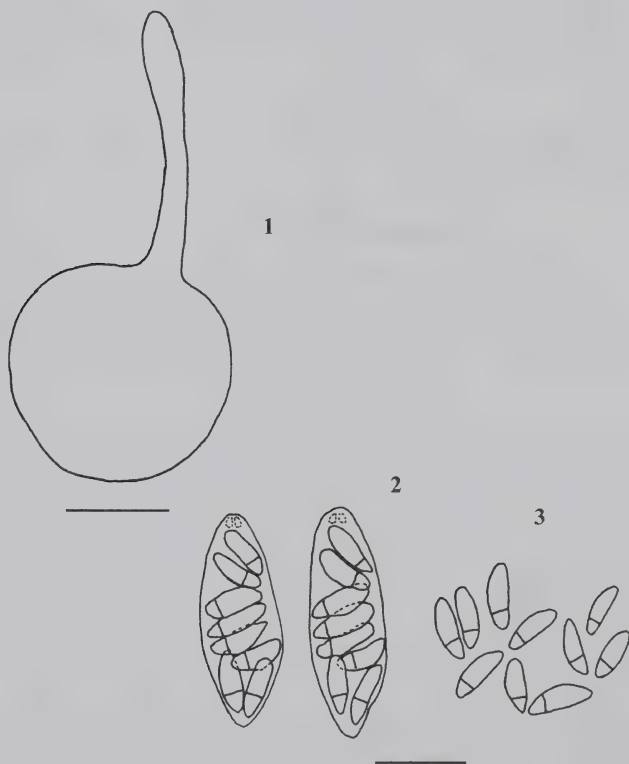


Fig. 1. *Apiognomonina fakirovae*: 1) perithecium; 2) asci; 3) ascospores.

Scale bars: 150 μm for perithecium, 10 μm for asci and ascospores (Stoykov, 24215; Holotype)

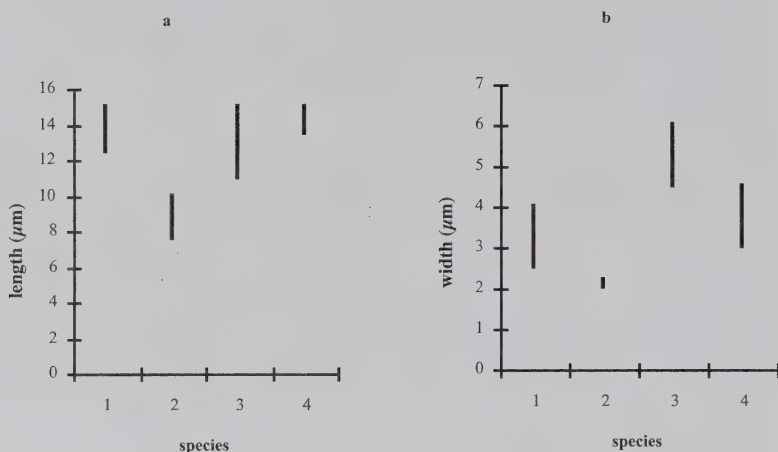


Fig. 2. Variation of length (a) and width (b) measurements of the ascospores:

1. *A. errabunda*; 2. *A. fakirovae*; 3. *A. suprasetata*; 4. *A. veneta*.

This specimen has been previously reported as *Gnomonia clavulata* Ellis (Stoikov & Fakirova 2001).

Note: Measurements of the perithecia, beak, asci and ascospores are taken in mounting media of lactophenol (Kirk et al. 2001).

Acknowledgements

The author wishes to thank Prof. Dr Margaret Barr Bigelow (Sidney, BC, Canada), Assoc. Prof. Dr Cvetomir Denchev (Institute of Botany, Sofia), Dr Michel Monod (CHUV, Lausanne, Switzerland) and Dr Larissa Vasilyeva (Institute of Biology and Soil Science, Russian Academy of Sciences, Vladivostok, Russia) by critically reading the manuscript and helpful suggestions.

Literature Cited

- Barr ME. 1978. *Diaporthales* in North America with emphasis on *Gnomonia* and its segregates. Mycol. Mem. 7: 1-232.
- Barr ME. 1991. Revisions and additions to the *Diaporthales*. Mycotaxon 41: 287-305.
- Denchev, CM. 2005. Violeta I. Fakirova (1936-2004). Mycol. Balcan. 1: 209-211.
- Kaneko S, Kobayashi, T. 1984. Fungi inhabiting fagaceous trees V. Three species of *Diaporthaceae* on evergreen oak trees. Trans. Mycol. Soc. Japan 25: 11-19.
- Kirk PM, Canon PF, David JC, Stalpers JA. [eds] 2001. Ainsworth & Bisby's Dictionary of the fungi. 9th ed. CAB International, Oxon.
- Merezhko TA, Smyk LV. 1991. Flora Fungorum RSS Ucrainicae *Diaporthales*. Naukova Dumka, Kiev.
- Monod M. 1983. Monographie taxonomique des *Gnomoniaceae*. Sydowia, Beih. 9(2): 1-314.
- Monod M. 1984. *Apiognomonia righetii*, une nouvelle espèce de la famille des Gnomoniacées. Sydowia 37: 222-223.
- Stoikov D, Fakirova V. 2001. A contribution to the study of the species of family *Gnomoniaceae* in Bulgaria. Phytol. Balcan. 7(2): 267-271.

Physarum styriacum*, a synonym of *Physarum vernum

G. MORENO, H. SINGER & C. ILLANA

gabriel.moreno@uah.es

Departamento de Biología Vegetal (Botánica), Universidad de Alcalá
28871 Alcalá de Henares, Madrid, Spain

Abstract—The holotype of *Physarum styriacum* was studied applying scanning electron microscopy techniques in order to examine spore ornamentation. The synonymy of *Physarum styriacum* with *P. vernum* is proposed.

Key words—Myxomycetes, nivicolous species, synonym, taxonomy

Introduction

When studying the nivicolous Myxomycetes, great care is needed because aberrant forms are caused by variation in climatic conditions under which these organisms fructify.

Meylan (1932), the “father” of the nivicolous Myxomycetes, recognized this problem and stated: “ce sont les formes mal développées et anormales qui ont été pour moi le plus grand obstacle à une vue nette et claire de ce groupe”.

Martin & Alexopoulos (1969) indicate that cold weather and especially frost can affect the development of the plasmodium to the fruiting body and cause great variations. Stalked species may become sessile, or the stalks can be excessively long. Sporocarpous species can be plasmodiocarpous and aethalioid forms may fructify in the form of sporocarps. Calcareous secretion may also be altered and maturation of the spores can be checked, resulting in spores much larger than the completely matured ones.

Stephenson & Stempen (1994) observed that generally the fruiting bodies of nivicolous Myxomycetes show a tendency to be more robust than the fructifications of other species and that “alpine fruitings of species also occurring in lowland habitats are characterized by spores that are somewhat larger than typical spores”.

In our experience this phenomenon has led to the description of new aberrant species that have afterwards been synonymized with normally fruiting species. This has been the case of *Diacheopsis spinosifila* M.L. Farr & R.L. Critchf., which has been synonymized with *Lepidoderma didermoides* Kowalski (Moreno et al., 2003a), *Diderma nigrum* Kowalski with *Diderma asteroides* (Lister & G. Lister) G. Lister (Moreno et al., 2003b), *Lepidoderma didermoides* Kowalski with *Lepidoderma chailletii* Rostaf. (Moreno et al., 2004) and *Trichia synspora* Kowalski with *Trichia varia* (Pers. ex J.F. Gmel.) Pers. (Singer et al., 2003).

Materials and Methods

The specimens were studied with a binocular microscope and, after mounting in Hoyer's medium, with a Nikon (Optiphot) microscope. Spore measurements were made under an oil immersion objective and include surface structures such as spines or warts.

Scanning electron microscopy (SEM) micrographs were taken in the University of Alcalá de Henares using a Zeiss DSM-950. In order to examine the spore ornamentation the critical point drying technique was applied to the specimens according to the protocol we indicate here: SEM-preparation was made from sporocarps rehydrated in concentrated ammonium hydroxide (28-30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1,2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hours followed by critical point drying and sputtering with gold-palladium.

Taxonomic Description

Physarum styriacum Gottsb., Nova Hedwigia 12: 245 (1966)

FIGURES 1-5

ORIGINAL DIAGNOSIS — *Plasmodium* ?. *Sporangia* albida, sessilia, subglobosa usque ad 0.5-1 mm diam., plerumque confluentia in plasmodiocarpis ramosos. *Peridium* tenuissimum, fragillimum, inspersis albis soris calcareis granulosum, lacerodehiscens, demum evanescens, proprie albidum uti prius, sed sporis translucentibus fusco-atrum. *Columella* nulla. *Capillitium* reticulatum, hyalinum. *Nodi* permulti, valde irregulares, plus minusve dilatati et soris calcareis angulatis vel fere lobatis albis repleti. *Sporae* plerumque fere globosae (17-)18-20(-22) μ m diam. vel rarius subovatae, 18-28:13-18 μ m diam., purpureo-fuscae, dense et saepe irregulariter spinulosae. Differt a *Physarum vernum* Somm. et *P. cinereum* (Batsch) Pers. in primis sporis fere duplo majoribus, interdum subovatis, irregulariter spinulosis.

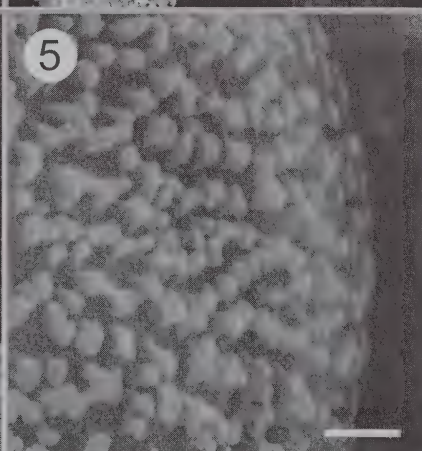
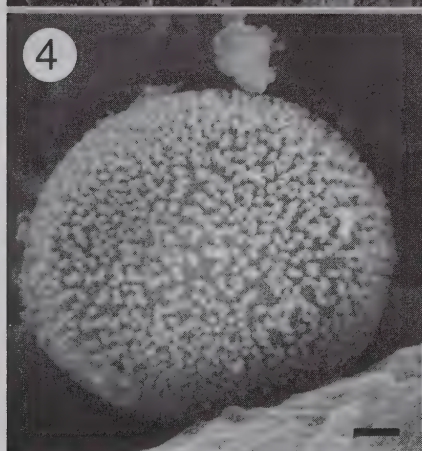
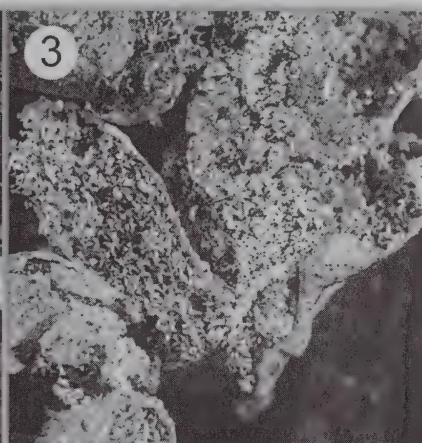
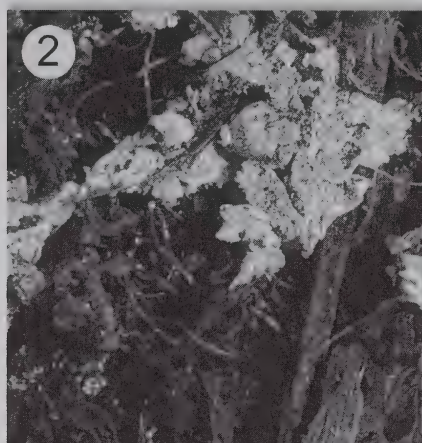
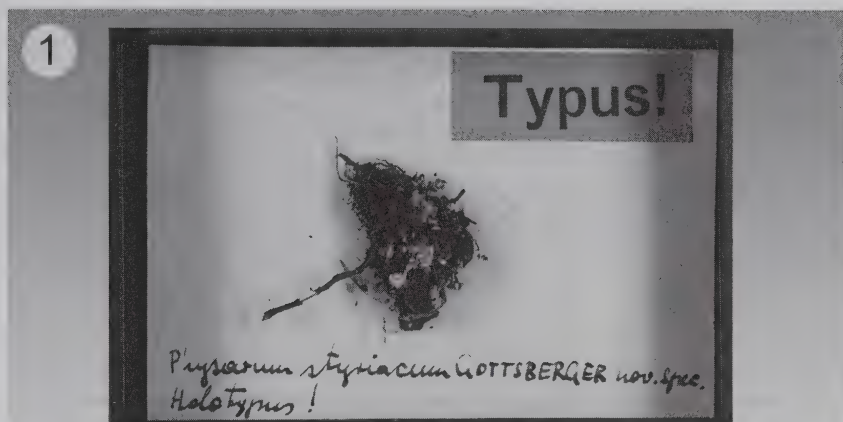
SPECIMEN EXAMINED — **AUSTRIA**: Ostalpen, Grazer Bergland, on the west slopes of the Hochlantsch, about 1500 m, on the edge of snow spots, 23-V-1963, leg. H. Teppner, holotype in herbarium GZU.

DESCRIPTION — The studied type is stuck on a card that once again is stuck to the bottom of a metal box. The specimen is composed of several sporocarps growing on remains of bryophytes.

Fruiting bodies elongate, cramped, forming short plasmodiocarpis, 2-3 x 0.8-1 mm. *Peridium* double; *exoperidium* calcareous, rugose, whitish; *endoperidium* membranous, yellowish brown. *Capillitium* with abundant whitish elongate to irregular nodes (badhamioid appearance) and short hyaline filaments. Spores dark violaceous brown in mass.

Spores of variable morphology, globose 16-22 μ m and oval 20-28 x 15-19 μ m, violaceous brown with clearer bands, bearing dense spines. Under SEM spore ornamentation formed by dense baculae with broad and flat apices.

FIGURES 1-5. Holotype of *Physarum styriacum*. 1. Box where type material is kept. 2. Fruit bodies. 3. Detail of badhamioid capillitium. 4. Spore (bar = 2 μ m). 5. Detail of spore ornamentation (bar = 1 μ m).



COMMENTS — Gottsberger (1966) already pointed out that the differences between *Physarum styriacum* and the closest species like *P. vernum* and *P. cinereum* are minor. *Physarum vernum* is also a nivicolous species and has smaller spores, 9–12 μm , whereas *P. cinereum* is not a nivicolous species, with spores of smaller dimensions, 7–10 μm . However, he considered this difference to be sufficient for establishing *Physarum styriacum* as a new species.

Recently we have studied the type of *Physarum vernum* (Singer et al. 2004) and we have come to the conclusion that this species produces whitish fructifications forming plasmodiocarps, a capillitium with abundant fusiform lime nodes and spores with two possible diameters and ornamentations: *Physarum vernum* f. *vernum* shows spores (12–)13–14(–15) μm in diam., with a dense and regular ornamentation, seen under SEM as composed of slender solitary baculae without broad apices. *Physarum vernum* f. *parvisporum* has spores (10–)11–12 μm in diam., with a more lax and irregular ornamentation, formed by baculae with broad apices that merge in groups of two or three.

The type material of *Physarum styriacum* is formed by a fructification that has developed spores of a variable morphology, regarding form (spherical and oval spores as well as some deformed ones are observed) and size (in the same preparation we observe very large spores, other very small ones, and intermediate spores). According to our experience this occurs when the material has fructified in an unsatisfactory way due to environmental factors. However, the external morphology (peridium) is well conserved, a well developed badhamioid capillitium is present, similar to that of *Physarum vernum* f. *badhamioides* Meyl., recently studied by Singer et al. (2004), with which it shares also the same type of spore ornamentation. We can conclude that we are dealing with a synonym of *Physarum vernum* s. lato, more specifically of *Physarum vernum* f. *parvisporum*, due to the presence of baculae with broad and flat apices, representing a gigantism of the latter taxon.

Physarum cinereum is without doubt a species very close to *P. vernum* and its interpretation has been different according to the authors (Singer et al. 2004). Most investigators distinguish *Physarum vernum* by its more robust and more plasmodiocarpic fructifications and by its larger and darker spores. Unfortunately we have not been able to locate the type material of *Physarum cinereum*, and thus we could not confirm the separation of these species.

Physarum styriacum has been cited from the Netherlands by Nannenga-Bremekamp (1974) and from Japan by Nannenga-Bremekamp & Yamamoto (1987). The Dutch specimen was found on rotting grass and *Fucus* sp. and according to Nannenga-Bremekamp it resembled *P. compressum* Alb. & Schwein. The only similarity with *P. styriacum* that she stated was that some of the lime nodes were lobed, as described for this species, but differed by being non-nivicolous and by having smaller fructifications and spores. The specimen from Japan was gathered on a dead twig of *Citrus* sp. It also is not nivicolous and has smaller spores with a tendency to form clusters, with another type of spore ornamentation. We consider that both collections should be revised in order to ascertain their correct taxonomic position.

Acknowledgements

This investigation has been partly financed by the Research Project of the Ministry of Science and Technology, National Plan of Scientific Investigation, Technological Development and Innovation, REN2002-01965. We express our gratitude to Dr. R.P. Korf, Mme. M. Meyer and Mr. D.W. Mitchell, for the revision of the manuscript and wish to thank Mr. J.A. Pérez and Mr. A. Priego of the Electron Microscopy Service of the University of Alcalá for their invaluable help with the SEM and Dr. J. Rejos, the curator of the herbarium AH, for the loan of the type material.

Mr. H. Singer thanks the National Program of the Professorship Formation, Ministry of Education and Culture of Spain, the conceded scholarship for the realization of his doctoral thesis in the University of Alcalá.

Literature Cited

- Gottsberger G. 1966. Die Myxomyceten der Steiermark mit Beiträgen zu ihrer Biologie. Nova Hedwigia 12: 203-296.
- Meylan C. 1932. Les espèces nivales du genre *Lamproderma*. Bull. Soc. Vaud. Sc. Nat. 57: 359-373.
- Moreno G, Singer H, Illana C. 2003a. *Diacheopsis spinosifila*, a synonym of *Lepidoderma didermoides*. Mycotaxon 88: 123-128.
- Moreno G, Singer H, Illana C, Lizárraga M. 2003b. *Diderma nigrum*, a synonym of *Diderma asteroides* (Myxomycetes). Österr. Z. Pilzk. 12: 23-29.
- Moreno G, Singer H, Illana C. 2004. A taxonomic review on the nivicolous Myxomycete species described by Kowalski. II. Order *Physarales* and *Trichiales*. Österr. Z. Pilzk. 13: 61-74.
- Nannenga-Bremekamp NE. 1974. De Nederlandse Myxomyceten. Koninklijke Nederlandse Natuurhistorische Vereniging, Zutphen.
- Nannenga-Bremekamp NE, Yamamoto Y. 1987. Additions to the Myxomycetes of Japan III. Proc. Kon. Ned. Akad. Wetensch., C. 90: 311-349.
- Singer H, Moreno G, Illana C, Lizárraga M. 2003. *Trichia synspora*, a synonym of *Trichia varia*. Mycotaxon 87: 243-248.
- Singer H, Moreno G, Illana C. 2004. A SEM-study of some types of nivicolous *Physarales*. Österr. Z. Pilzk. 13: 75-89.
- Stephenson SL, Stempen H. 1994. Myxomycetes. A handbook of slime molds. Timber Press. Portland, Oregon.

MYCOTAXON

Volume 92, pp. 469–496

April–June 2005

Book reviews and notices

Compiled by

DAVID L. HAWKSWORTH¹

*MycNova, The Yellow House, Calle Aguila 12, Colonia La Maliciosa
Mataelpino, ES-28492 Madrid, Spain*

Since I was entrusted with the preparation of this column in 2000, the books and reviews have been obtained through one of seven routes: (1) unsolicited copies submitted by the publishers; (2) books sent following a request to the publishers; (3) ones personally purchased; (4) personal gifts from authors and editors; (5) works seen in libraries visited; (6) books intercepted when crossing my desk for review elsewhere; and (7) unsolicited reviews submitted by other mycologists. Most books covered result from the first two sources, and publishers are generally most co-operative, recognizing the promotional value of their products being drawn to the attention of mycologists in *Mycotaxon*.

However, there are two trends that are of concern and contrary to the spirit of the frank peer debate so necessary for a healthy science. First, publishers who positively refuse to submit complimentary copies of their books even when they are of major systematic importance. Second, publishers who threaten not to send future works following unfavourable reviews, unless they are assured of only positive remarks being made.

In consultation with the Editor-in-Chief and the Managing Editor, and starting with this issue, a “name and shame” policy is now being implemented in this column of *Mycotaxon*. In cases where publishers have refused to submit complimentary copies, either the works will be reviewed from other copies and published with a footnote to indicate this refusal, or the title will be listed with the statement “Review copy refused by the publisher, implying that the work does not merit coverage in *Mycotaxon*.” Examples of both cases are included in this issue.

¹Books for consideration for coverage in this column should be mailed to the Book Review Editor (address above) in the first instance. Fax (+34) 91 857 3640; e-mail: myconova@terra.es.

General

CBS Centenary: 100 Years of Fungal Biodiversity and Ecology. Edited by Pedro W. Crous, Robert A. Samson, Walter Gams, Richard C. Summerbell, Teun Boekhout, G. Sybren de Hoog & Joost A. Stalpers. 2004. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [Studies in Mycology No. 50 (1-2).] 2 vols. Pp. 586. ISBN 90 70351 54 4, Price: € 100.

This magnificent *Studies in Mycology* number 50, published in two consecutively numbered parts, celebrates the centenary of the founding of the Centraalbureau voor Schimmelcultures (CBS). The two similar-but-different collages of photogenic microfungi on the two covers are representative of the 51 articles contributed by the worldwide community of mycologists. The printing on high-quality paper is clear. The numerous illustrations are primarily black and white photographs with a few line drawings and at least 30 coloured plates liberally sprinkled through both volumes adding to the majesty of this publication.

One of the stated goals of this number was “a publication dealing with the description of at least 100 new species, to celebrate the vast, untapped wealth of fungal diversity that surrounds us every day.” This goal was accomplished with 118 taxa described as new to science in the 49 taxonomic articles, which range in size from 4–26 pages. As a result, this publication reads more like a journal than the monographic accounts of a single genus or related group of fungi usually published in the irregularly issued *Studies in Mycology*. A second requirement was that “all strains had to be treated in a manner reflecting the current state of the art in the specific group, thus incorporating the various types of data sets used today.” For most papers, this requirement is evidenced by molecular sequence data in which the new taxa are placed in phylogenetic trees. In addition, cultures for all new taxa have been deposited at CBS, and thus are available to future mycologists. Finally, CBS has evidenced its forward-thinking leadership and service to mycology by placing this publication on-line and thus making it available to everyone free of charge.

The majority of the papers address the systematics of filamentous ascomycetes and their anamorphs, especially plant-associated microfungi. Not surprisingly, most papers describe new taxa and many of them include keys to genera such as for *Chaetomidium*, *Chaetosphaeria*, *Hapalocystis*, *Monascus*, *Oidiodendron*, and *Spirosphaeria*. Obviously many mycologists harbour unpublished new taxa in their offices and laboratories; this call for new species descriptions provided the occasion to finally legitimize some of these latent genera and species. What a relief to see a new genus for an important biocontrol fungus: *Coniothyrium minitans* has long been known not to be congeneric with the type species of that genus and here Verkley and colleagues place this species (along with several others) in *Paraconiothyrium*, a new generic name that will be palatable to plant pathologists. Two papers address members of the *Botryosphaeria* complex, in which the phylogeny continues to become clearer with well-supported lineages that correlate with the easily recognized anamorph genera, *Fusicoccum*, *Dothiorella*, *Diplodia*, and *Lasiodiplodia*. While including trees based on molecular sequence data are valuable, this feature seems forced for some subjects such as Aptroot's description of two only distantly related ascomycetes placed in one tree. On p. 390 the use of the distantly related

Cercospora apii as an outgroup for the closely related *Calosphaeriales-Diaporthales* ensures that this group is united; it might have been wiser to use a more closely related outgroup. Even with these minor quibbles, all of the papers have been peer-reviewed and present excellent science.

Seven papers concern non-ascomycetes, including one very interesting paper on the history of CBS, one on global fungal biodiversity, a topic that this volume aptly illustrates, one on the new initiative MycoBank, two papers on true yeast fungi, one on an "accidental" basidiomycete (*Helicomyxa everhartioides*), one on *Pythium/Phytophthora*, and one on the *Mucorales*. The chapter on MycoBank describes this new initiative to issue numbers for new fungal taxa prior to publication, and making available new scientific names with descriptions and illustrations immediately following publication. While lofty in purpose, the website has yet to be launched and will need considerable care and attention.

The chapter on the history of CBS was enjoyable and revealing in the dedication of CBS personnel. Particularly inspiring is the account of Gerda Bunschoten who managed to keep the cultures alive during World War II while receiving no pay for her labours and under conditions in which the inhabitants of the occupied Netherlands were suffering from a severe famine. The photographs of the past to present Directors include Johanna Westerdijk with a playful smile in a formal pose and a more serious demeanour before stacks of cotton-plugged tubes. I especially enjoyed her mottos (translated): "Work and celebration: greatness comes from the combination" and "When life gets dull and monotonous, even a fungus dies off." This established tradition of combining work with fun will certainly continue under the directorship of Pedro Crous.

Congratulations to those who edited these 51 papers and produced this high quality landmark issue. Judging by the volume and quality of the publication, the future for CBS appears bright!

AMY Y. ROSSMAN

USDA-ARS Systematic Botany & Mycology Laboratory
Room 301, B011A, 10300 Baltimore Avenue
Beltsville, MD 20705, USA

Introduction to Fungi of New Zealand. [The Fungi of New Zealand Vol. 1.²] Edited by Eric H. C. McKenzie. 2004. Fungal Diversity Press, Centre for Research in Fungal Diversity, Department of Ecology & Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong S. A. R., China. [Fungal Diversity Research Series No. 14.] Pp. 498. ISBN 962 86765 6 3. Price: US \$ 80.

This book represents a milestone in the exploration of the New Zealand fungi, and forms a mandatory basis for all future major mycological studies in the area. The islands have been isolated for around 50 Myr and have a remarkable unique diversity in almost all groups of living organisms, and the fungi are no exception. Thus, from earlier times mycologists have been attracted to the islands, and this book clearly illustrates that there were good reasons for this interest.

² Two additional volumes in this series have previously been published: Vol. 2 (Smut Fungi, 2002; review copy not received); and Vol. 3 (Myxomycetes, 2003; see *Mycotaxon* **89**: 518-519, 2004).

Chapter 1 is a general introduction to fungi and is aimed primarily at laymen and students, although there are some interesting tables comparing the biodiversity in certain groups of fungi between New Zealand and the rest of the world. Chapter 2 is a historical survey of taxonomic mycology in New Zealand, while Chapter 3 deals with the Maori knowledge of fungi, emphasizing the most commonly used species, as both medicine and food.

For many, the most important part of the book will be Egon Horak's Chapter 4, which for the first time give keys to genera of agarics, boletes and related fungi for the country. In addition to the key is a long list of references to papers where the reader can find descriptions, illustrations and keys to species pertinent to New Zealand. This chapter will be most important for the numerous amateurs which previously have been frustrated and in many cases paralyzed by having to use keys from other areas of the world.

In Chapter 5, S. R. Pennycook has, over about 200 pages, brought together a bibliographic checklist of all agarics, boletes and related fungi recorded from New Zealand. Everyone doing monographic work with these groups of fungi in the future will send grateful thoughts to the author for making this tremendous painstaking effort to bring together all this useful information. In Chapter 6, the same S. R. Pennycook has brought together a 40 page bibliography of new Zealand taxonomic mycology, and the final Chapter 7 is a checklist of New Zealand fungi covering over 80 pages.

Everyone who has done a fair share of bibliographic work will understand that the mycological community at Land Care Research are to be congratulated for being able to collect all this information in such a condensed, but still pleasant book.

The illustrations are restricted to 16 separate plates showing beautiful pictures of representative species partly from systematic groups, but also based on ecology.

It goes without saying that everyone working seriously with macrofungi on an international basis must buy this book!

LEIF RYVARDEN

Botany Department, University of Oslo

P. O. Box 1045, Blindern, N-0316 Oslo, Norway

Macrofungi of North Korea collected in 1982–1986. By Wladyslaw Wojewoda, Zofia Heinrich & Halina Komorowska. 29 October 2004. W. Szafer Institute of Botany, Lubicz 46, PL-31-512 Kraków, Poland. [Polish Botanical Studies Vol. 18.] Pp. 289, figs 152. ISBN 83 89648 17 2. Price: € 50.

This is a welcome addition to the literature on the macromycetes of Asia. In the 9th edition of the *Dictionary of the Fungi* (Kirk et al. 2001) the macromycetes of this continent were only cited for China (Pfister 1985) and Sri Lanka (Pegler 1986).

In the book, 429 species of macrofungi and two of microfungi (*Asco-* and *Basidiomycota*) together with distributional notes, are reported based on 1460 specimens collected in North Korea at 65 sites located in the Province of Kaesong in the south and the territory below the 42nd N parallel. The fungi of North Korea have not previously been studied in detail. Indeed, information on the fungi of this country was only published in Korean in the period 1978–83. The book includes 259 species reported for the first time from North Korea. The material was collected during five expeditions to Korea between 1982–86. For each collected species, the information given includes a short description

of its macro- and microscopic features, sites and substrate, accepted name and synonyms with its basionym, and references concerning its taxonomy and geographical distribution, mainly for Asia. Characteristics of the North Korean mycobiota, including the fungi collected in seven mountainous regions of the country, are given. According to Wu & Mueller (1997), the macromycetes of East Asia fall into nine major areas from the circumpolar to tropical southeast Asian. Ecological characteristics of North Korean fungi given consist of a list of fungi associated with certain trees, mycophilous, coprophilous, entomophilous, synanthropic, common, edible, and poisonous, fungi.

In this work, 13 species belong to the *Ascomycota* and 419 species to *Basidiomycota*, including 417 species of *Basidiomycetes*; all are presented in detail. The class *Basidiomycetes* is divided into 16 orders (Kirk et al. 2001), of which 12 are described. The percentage of fungi collected in North Korea is closely related to the species of fungi belonging to one of the 12 orders of *Basidiomycetes*.

This book should be of great scientific use to professional mycologists, since so many species were collected and identified in North Korea for the first time. To stress its value, it is worth referring to the results of investigations into the phylogeography of *Hyphoderma setigerum* in the Northern Hemisphere presented by Nilsson et al. (2003). In that study, 45 collections of this species were examined, from Norway, Greenland, Germany, Finland, Sweden, Russia, Romania, Canada, Japan, USA, mainland China, Taiwan, and the UK. The variations in DNA sequences from the nuclear ribosomal ITS region were analysed, including morphological studies and crossing tests. However, the size of spores of *H. setigerum* collected in North Korea, given as 6–11.4 x 3.6–5.4 μm , is so different from that of material collected in the above 13 countries that the study by Nilsson et al. (2003) will probably require revision and the phylogenetic tree changing.

While it is also good to see the careful attention paid to the places of publication of names, which are accompanied by full bibliographic citations of both accepted names and synonyms, some citations have to be treated with caution.³

This book, prepared by Polish mycologists, fills a major gap in our worldwide knowledge on the macrofungi of the huge Asian continent, and so deserves to be widely known.

Kirk PM, Cannon PF, David JC, Stalpers J. (2001) Ainsworth & Bisby's Dictionary of the Fungi. 9th edn. Wallingford: CABI Publishing.

Nilsson RH, Hallenberg N, Nordén B, Maekawa N, Wu S-H. (2003) Phylogeography of *Hyphoderma setigerum* (*Basidiomycota*) in the Northern Hemisphere. *Mycological Research* 107: 645-652.

Pegler DN. (1986) Agaric flora of Sri Lanka. *Kew Bull. Addit. Ser.* 6: 1-615.

³ A common mistake consistently made throughout the work is that in the case of sanctioned names, the place of publication and dates of sanctioning are cited as if they were separate names. To take one page as an example of many, on p. 63, the actual place of valid publication of the name *Lycoperdon excipuliformis* and the date of the epithet is the work of Scopoli of which details are not given; the name is then repeated as if a separate validly published name with the authorship "Scop.:Pers." and the place of sanctioning by Persoon given as if it were the place of valid publication of the name. On the same page, there is only one validly published name *Bovista plumbea* Pers. 1796 – there is actually no separate "name" to be attributed to "Pers.:Pers. 1801" as indicated. [Ed.]

- Pfister DH. (1985) Illustrations of fungi in the Farlow Reference Library; with the mycological paper of N.T. Patouillard. Introduction by D.H. Pfister. Cambridge, MA: Farlow Herbarium.
- Wu SH, Mueller GM. (1997) Biogeographic relationships between the macrofungi of temperate eastern Asia and eastern North America. *Canadian Journal of Botany* **75**: 2108-2116.

BRONISLAW ZYSKA

Wolności Street 7, 41-500 Chorzów, Poland

Basidiomycetes

Amaniteae: Amanita, Limacella & Torrendia. By Pierre Neville & Serge Poumarat. 2004. Edizioni Candusso, Via Ottone Primo 90, I-17021 Alasio (Savona), Italy. [Fungi Europaei Vol. 9.] Pp. 1120 figs 128 [photographs and line drawings], col. photographs [194 numbered 1-92C], plates 103 [mostly in colour]. ISBN 88 901057 3 9. Price: € 78.

This book deals largely with European taxa of what most authors would call the *Amanitaceae*. It represents the result of an impressive amount of research — a combination of compilation and original work. If the user is interested in determining European collections to species and in colour illustrations of the fungi, both in photographs and historic plates, he/she will, to a great degree, be satisfied with the utility of this tome. Some predominantly northern European taxa (e.g. *Amanita regalis*) will be found to be less satisfactorily treated than others. It is valuable that all three of the genera accepted in the tribe *Amaniteae* and represented in Europe are included: *Amanita*, *Limacella*, and *Torrendia*. *Amarrendia* is mentioned, but not treated in detail. In all, 102 taxa of specific and infraspecific rank are treated in detailed descriptions while three others appear only in keys: the single European species of *Torrendia* is accepted; 14 taxa are accepted (one provisionally; seven species and eight forms), and four species rejected in *Limacella*; and in *Amanita*, 90 taxa are accepted comprising 38 species, 41 varieties, 46 forms, and five subforms (counts of infraspecific taxa include autonyms when there is at least one non-autonym in a category). The *Amanita* taxonomist or systematist will find the book at once informative, idiosyncratic, and persistently problematic.

Non-Europeans, especially those workers desiring to understand taxa from which their endemic entities are to be differentiated, will also be aided by the book, although it is worth warning that the authors' understanding of the occasional North American or east Asian taxon addressed is limited. In at least three cases, their representations are incorrect (*A. muscaria* var. *flavivolvata*, *A. muscaria* var. *formosa*, and *A. rubescens* var. *alba*); in another, '*A. flavorubescens*', is burdened by illogical treatment of nomenclature as well as being a possible misapplication. They are incorrect in assuming that *A. singeri* is known from North America or that *A. nauseosa* is known in the Americas south of the Caribbean. *Amanita caesareoides* is correctly cited as having no type designated, but there is original material of this species in St Petersburg (LE).⁴

⁴ C. Bas (L) reviewed two collections (the known original material) of *Amanita caesareoides* (loaned to him from LE) and retained a set of notes. I also reviewed the specimens when visiting L and made some annotations. One collection was in very poor condition and not very useful. The other was in better condition, although not entirely revealing concerning its anatomy. Nevertheless, the species is clearly a member of stirps *Hemibapha* (inamyloid spores, shallow subhymenium, the presence of clamps, a totally elongating and annulate stipe, universal veil as a copious sack

The authors have chosen to leave to a future companion volume the exannulate taxa of both sections *Amanita* and *Amanitopsis* (their proposed replacement for sect. *Vaginatae* sensu Zhu L. Yang 1997, i.e. sect. *Vaginatae* sensu Corner & Bas 1962 less sect. *Caesareae*). The uniformity of the presentation of macroscopic characters of most taxa is an advantage, while a layout negative is the fact that titles move about on the page depending upon their place in the titling hierarchy. The hierarchy is sufficiently deep that a numbering scheme conveying the hierarchical position would have been helpful (e.g. use of the x.y.z. system) and would have allowed all sectional titles to be placed at the left margin. The text could benefit from a thorough editing. Presentations, decisions, and proposals are not always logical, as the authors make an unusual, explicit decision not to be bound by the requirements of what they call 'pure logic', a decision that negatively effects a number of taxonomic and systematic conclusions. I have not attempted to catalogue all taxonomic, systematic, and nomenclatural problems, but there are many. Examples are provided, below. Most newly designated holotypes have been placed in private herbaria — for the most part, those of the authors. Out of 105 taxa accepted (including typeless provisional taxa), to have 29 types conserved in private collections (or in the case of material once in the possession of E.-J. Gilbert, probably lost) is very undesirable, and contrary to the spirit of the *Code*. At a minimum, I would strongly encourage the distribution of isotypes to well-established public collections that can properly care for deposited material in the long term and make it freely available to other researchers. Among the taxa treated, type collections in public herbaria number 19 (after designation of one lectotype in this review). However, 19 of the treated names remain untypified, and plates now serve as types for 37 taxa. Typification of the remaining taxon (*A. junquillea* var. *amici*) appears not to be discussed.

The work treats about 8 % of the world's named species of *Amanita* in toto, or 10 % of those falling under supraspecific taxa treated in the present work. In terms of the sections as treated by Yang (1997), this breaks down as follows: sect. *Amanita* has 11 % of described world taxa treated in this book; subsect. *Caesareae*, 6 %; sect. *Lepidella*, 7 %; sect. *Amidella*, 26 %; sect. *Phalloideae*, 11 %; and sect. *Validae*, 11 %. For a very rough estimate of such percentages with regard to projected total taxa in the world (Bas 2000, Tulloss 2000a), values given should be multiplied by 0.6.

Apparently, the publication was not subject to critical review by any leading specialist on the genus *Amanita*. Neither the primary Asian expert on *Amanita* (Zhu L. Yang) nor the primary European expert on *Amanita* (C. Bas) is acknowledged even as a correspondent. This indicates that this work was developed in some isolation from leading modern taxonomists of *Amanita*. I did not note any correspondent from the Western Hemisphere mentioned other than myself, and I only exchanged literature with

at the stipe base, etc.). The label of the better original collection (in Russian) was an official label of "Academician V. L. Komarova Far Eastern Base of the Academy of Sciences of the USSR". Further the label (transliterated) reads, "Primorskii krai, Voroshilovskii raion, Gorno-Tae[?]snaya stanzija, molodoi dubnyar[?]." The collector is L. Vassiljeva, and the date is 23 Aug. 1945. Further markings include "II.1948" and "Tip. No. 3 Zak. No. 289 t. 4000". The collection so identified satisfies the locality, date, collector, and habitat ("[in young] oak forest") information provided in the protologue and is herewith designated the lectotype (*lectotypus hic designatus*) of the name *Amanita caesareoides* Lju. N. Vassiljeva, *Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk SSSR* 6(7-12): 199 (1950).

the authors and was not consulted with regard to the book. Looking only at the issue of potential improvements to microscopic descriptions, I estimate an additional month or two of work would have greatly enhanced the book's taxonomic value. A programme of correspondence with mycologists of northern Europe could have converted the treatment of some taxa largely reliant on compilations to treatments equal to the better ones in the work — as long as the authors would accept working with dried material. Correspondence with mycologists at K, L, NY, S and other herbaria would have located relevant authentic collections (e.g. of *A. gilbertii* var. *subverna* and *A. lepiotoides*).

The book is divided into the following sections: 1, Sommaire; 2, Résumé; 3, Taxons, combinaisons et noms nouveaux, amendements; 4, Introduction; 5, Remerciements; 6, Matériel et méthodes; 7, Morphologie, anatomie et développement des *Amaniteae*; 8, Toxicité chez les *Amanita*; 9, Examen critique de la délimitation des *Amaniteae*; 10, Taxons supraspécifique d'*Amaniteae* jusqu'au rang de genre; 11, Présentations des taxon retenus; 12, Photographies; 13, Planches; 14, Bibliographie; and 15, Index.

Illustrations

Although some have a slightly red tint to my eye, the colour photographs are generally of good quality, with the exception of several in which the material photographed was not in prime condition. Those of '*A. junquillea*' do not include any with colouring similar to that of the lectotype plate. Reproduction of previously published plates, and the fine watercolours of the late E. Rebaudengo, are often good, but the Barla plate of *A. lepiotoides* is much darker than the original. With the exception of line drawings reproduced from (Bas 1969), drawings of microscopic anatomy are of less value (e.g. a pair of basidia without showing even one complete cell of the subhymenium to which the basidia are attached).

Literature cited

The bibliography is extensive, covering 59 pages. The authors have clearly read and considered most, if not all, of the taxonomically important literature cited in considerable depth; and citations are appropriately frequent throughout the text. While nomenclatural histories are not always complete, they are often more extensive than one normally sees, and this achievement deserves acknowledgment. However, the authors do not always give evidence of carefully judging the relative reliability of sources.

Title

The treatment of tribe as the highest rank including only genera most closely related to *Amanita* is due apparently to the time of writing and lack of access to research and publications available after a certain point in 2002. Particularly important to the book's content is that Moncalvo et al. (2002)'s phylogenetic study indicating *Pluteus* and *Amanita* as sister genera was interpreted by Neville & Poumarat to suggest that the *Amanitaceae* as a whole should be placed within the *Pluteaceae*. That hypothesis is not supported by morphology nor by more recent molecular phylogenetic work. Based on this one molecular study, the authors propose eliminating the family *Amanitaceae*, and recognizing a tribe *Amaniteae* within the *Pluteaceae*. They offer no argument *against* doing so, but simply plunge in without trepidation. It is notable throughout the present work, that they appear to see a balanced treatment of pros and cons as acknowledgment of a flawed final choice or an admission of weakness in an argument. Perhaps this is

why they provide only minimal justification for some significant choices, and few if any counter arguments. The unique form of basidiome development in *Amanita*, alone, should give enough pause so that some questioning ought to have occurred before a major revision at such a high rank was adopted.

Methods

Several pages review the methods used, adopted in part from Bas (1969), Jenkins (1977), Kotilová-Kubičková (1982), Yang (1997), Tulloss (2000b), etc. Unfortunately, the section begins with a long list of works (many neither monographic nor intended as models for methodology, but labeled as such), which is somewhat misleading. While they state they will not treat certain characters, in the descriptions they occasionally do so. The reader is referred to Tulloss (2000b), although the authors state the methods of that work are more complex than those they adopt. Spore measurements are taken from water mounts using only spores from fresh material that has not been refrigerated. This is an unusual limitation for a monographic work, but an interesting, rather large scale experiment otherwise. Perhaps the choice explains in part why, for many taxa, so few spores are reported measured (e.g. only 40 from the common *A. muscaria*). In addition, the fresh-spores-only choice may have prevented the obtaining of detailed knowledge about species occurring outside the authors' major collecting area. The present work is one of the few treating the amyloid reaction of hyphal plasma reported by Kotilová-Kubičková.

For the most part, treatments of macroscopic characters can be positively compared to those in other recent publications on *Amanita*. The existence and placement of the limbus internus of the universal veil (especially in sect. *Vaginatae* sensu Corner & Bas 1962) is given significant space with illustrations; this is welcome as this character is often not reported, or not reported correctly, in notes from fresh material. One element of this section that may lead to confusion is the common mistake of thinking Bas segregated the inamyloid taxa of *Amanita* by placing those with a basal bulb in sect. *Amanita* (typified by *A. muscaria*) and those lacking a bulb in section *Vaginatae* sensu Corner & Bas 1962. The character utilized originally by Bas (1969) and thereafter by Jenkins, Tulloss, Yang, and others is not the bulb/no bulb dichotomy, but the position of the developing stipe in the primordium. There is a subtle difference: if the developing stipe is eccentric, there is often a basal bulb in the mature basidiome, but a very small or very narrow bulb at maturity may not provide the information for proper placement to section. If the stipe develops centrally, a bulb is almost always lacking and the stipe (in Bas' terminology) is 'totally elongating'. The explanation of chemical spot testing of fresh material unfortunately does not provide the names of the reagents that are most precise among phenolic compounds for distinguishing the presence of specific phenoloxidases (Marr 1979, Tulloss 2000b).

The section on microscopic characters is frequently illustrated by figures from Bas (1969). The choices to avoid describing marginal cells of lamellae, vascular hyphae (called 'oléifères'), details of the pileipellis and its timing of gelatinization, and the many details of the lamella trama are unfortunate. In the planned companion volume of *Amaniteae*, the authors will treat the numerous European taxa of *Amanita* sect. *Vaginatae*. Recent attempts to give order to this section have been continuing over more than ten years, and, in my opinion, depend upon the very characters, among others, that

the *Amaniteae* authors set aside. They are quite correct in citing the origin of the relevant methods (i.e. Bas 1969) and identifying me as having derived or promoted relevant methods. The authors would prefer not to adopt my methods for study of the lamella trama (nor to improve on them) because they have not been proven to their satisfaction. The authors are unaware of the dozens of type studies and many descriptions of new taxa that are in progress in my laboratory and the significant quantity of work under way by Yang and his students using Yang's related methods. The whole purpose of developing techniques that might help with taxonomy of sect. *Vaginatae* is to gather the very data about which Neville & Poumarat are concerned. Having heard the taxonomic folk tales of researchers working all their lives only to find out that they had failed to collect data on one or two critical characters, I would prefer to gather as much data as possible. Yes, I personally find it difficult to make the sections I need. It's also terribly time consuming to measure globose spores if you insist (as I do) that they only be measured when viewed laterally. It takes days to thoroughly investigate a single collection of an amanita. If you have to make three sections instead of one because they are hard to make, if you have to draw complex tissue so that you can see what is before your eyes in the microscope, is this not a relatively small price to pay if, in the end, a difficult group becomes tractable to taxonomy? I find it frustrating that questions that might have been answered in the preparation of this book have been left for future workers.

Toxicity

Information on toxins receives only four pages, and other extrolites ('secondary metabolites') are not treated. I wish there had been more space given to the particular heavy metals and other toxins that are taken up by fungi and to specific evidence of the uptake by taxa in the *Amanitaceae*. A table compiling what is known of the products of different species would have been a valuable addition. Since the work on toxins in *Amanita* is much more limited with regard to taxa studied than one would think, it is helpful to offer some observations such as noting that when one taxon in a taxonomic grouping is known to contain a toxin, in the absence of other evidence, the other taxa in that grouping should be suspected to contain the same toxin. This is done specifically for taxa related to *A. muscaria* and *A. pantherina*, but not generalized. The absence of recent information concerning amino acid toxins in sect. *Lepidella* is unfortunate. Since two recent poisonings in North America have involved taxa of subsection *Vittadiniae* (one with serious renal impact involving *A. nauseosa*) and since at least three taxa of this subsection occur in Europe in the wild, it would appear that cautions concerning "syndromes tardif" should include information on poisonings by amino acids if there is an opportunity for revision of the book.

Names

The authors propose the elimination of some names that have been at the core of *Amanita* systematics since 1962. Within *Amanita* subg. *Amanita*, they accept only sect. *Amanita*, while proposing that sect. *Vaginatae* be replaced by sect. *Amanitopsis* (in accord with the *Code*, but undesirable in my opinion). They treat the *Caesareae* at subsectional rank. The latter choice seems appropriately conservative since taxa with subhymenia not comprising layered inflated cells (taxa outside of stirpes *Caesarea* and *Hemibapha* (Tulloss 1998)) have hardly been dealt with; and the borderline between the *Caesareae* and the *Vaginatae* sensu Yang is unexplored. Within *Amanita* subg. *Lepidella*, they

propose the name sect. *Roanokenses* as a replacement for sect. *Lepidella*. The proposals appear to be in accordance with the *Code*.

I solicited the opinion of Zhu L. Yang on the sectional names proposed to be replaced, and he joins me in preferring to retain the sectional names that have been agreed upon throughout much of the world through the impact of Bas' work and its continuance in the hands of other researchers. Where necessary, we believe the sectional names used by Corner & Bas (1962) and Bas (1969) should be retained in the interests of nomenclatural stability.

The authors also propose conserving or rejecting three widely used species names: *A. citrina*, *A. gemmata*, and *A. solitaria*. It is an unhappy situation that discovery of the publication of *Agaricus citrinus* Gunnerus 1772⁵ requires the use of *Amanita bulbosa* var. *citrina* as the name of the common European taxon. This seems to me a case in which conservation of the more familiar *Agaricus citrinus* Schaeff. 1774 would be appropriate. Since Neville & Poumarat accept *A. citrina*, I assume that we are in agreement on conservation in this instance.

The case presented against *A. gemmata* is different and depends to a degree upon the supposed preference in common usage for *A. junquillea*. It may be true that the latter name is more commonly used in parts of the Mediterranean region (or, as the authors say, is increasing in usage since 1980); but, outside of Europe, the name *A. gemmata* is more commonly applied (and misapplied) in my experience. The authors provide an extended and convoluted argument that *gemmata* is really not the yellow species we think it is or at least that there has been a great deal of confusion about its application now and again during the history of European mycology. Both Paulet plates (1779 ['1776'] and ca. 1808 [not 1793]) illustrating his *Hypophyllum nitidoguttatum* nom. illegit. are original material of Fries' name, as would be material of Fries in UPS. Existence of the latter is unlikely because, as Neville & Poumarat point out, Fries apparently did not know the species from personal experience. Unfortunately, no selection of a lectotype has been made to my knowledge. Since the 1776 Paulet illustration depicts a common colouration (golden yellow) of the taxon known as *A. junquillea* and in the absence of actual specimens, I see no problem to designating this plate as lectotype, and so increasing the likelihood of preserving the earliest generally known and most commonly used valid name of the species.⁶

The proposal to reject *A. solitaria* seems to rely entirely on the following arguments: (1) early authors may have experienced confusion over the correct application of the name; (2) contemporary non-European authors misapply the name to taxa endemic to other continents; (3) some European authors prefer the epithet "*echinocephala*"; and (4) Bas (1969) presented arguments for and against his choice of *A. solitaria* as the correct name. In this set of propositions, I do not find any argument against the decision Bas made. Once again, the authors do not appear to understand the fundamental global import of Bas' work, and its 36-year-old position as the basis for modern usage of names in sect. *Lepidella* and the modern taxonomy of *Amanita* in general. Indeed, the

⁵ The date 1776 appears on some copies of this work. This is the date of a re-issue of the work with contents identical to those of the 1772 printing (Donald H. Pfister, pers. comm.).

⁶ *Agaricus gemmatus* Fr., *Epicr.*: 12 (1838) [syn. *Amanita gemmata* (Fr.) Bertillon, in Dechambre 1866 lectotype: Paulet, *Hist. Soc. Roy. Med. (Paris)* 1776: pl. 15 fig. 3 (1779) – *lectotypus hic designatus*).

majority of the world's students of *Amanita* beyond the authors' circle, have accepted the now clearly typified and clearly described *A. solitaria*, and I see no case made to reject that name.

Lecto- and neotypification

The authors designate eight new neotypes and 25 new lectotypes. These include at least two errors in typification. *Amanita phalloides* f. *alba* is incorrectly attributed; the name was proposed by Britzelmayr (*Ber. Naturhist. Ver. Augsburg* **30**: 6, [pl. 50] fig. 329, 1890) and this plate is the only candidate for lectotype. The neo- or lecto-typification of *A. phalloides* var. *alba* proposed cannot be based on the publication cited. Constantin & Dufour's 1895 publication including that name is preceded by at least two other relevant publications. The earliest proposal of *Agaricus* (*Amanita*) *phalloides* var. *alba* was by Duby & DC. (1830). Moreover, *A. bulbosa* var. *alba* Gillet 1874 is not illegitimate for the reasons given; arguably, the supposed anterior homonym was based on *A. bulbosa* Schaeff. 1774 (cited on a later page) and is invalid because it is an alternative name for an autonym, i.e. *A. bulbosa* var. *bulbosa*. If Duby's name did not exist or is rejectable for some reason, *A. phalloides* var. *alba* (Gillet) E.-J. Gilbert 1918 is a name that could be accepted as correct – if one believes the taxon is worthy of varietal rank.

One lectotype is designated for a North American taxon originally described by Coker, *A. citrina* f. *lavendula*. The "type" was selected by picking the first collection of 17 listed by Coker, without any knowledge of the status or quality of the collection in question. I have had Coker's material of this taxon on loan from NCU for several years. The selected "type" is the oldest of 17 potential syntypes and, unlike several others, was not photographed by Coker. Worst of all, the annotation based on the material when fresh makes clear that the colour lavender did not appear on any part of the specimens. It was irresponsible to select as lectotype material that the authors had not reviewed. Their selection of lectotype is to be rejected as not consistent with the protologue.⁷ An additional Coker name, *A. rubescens* var. *alba* is mentioned in *Amaniteae* and misapplied to European material. A lectotype for *A. rubescens* var. *alba* is designated here.⁸

⁷ I located 13 of the 17 collections cited by Coker in the protologue of *A. mappa* var. *lavendula*. Of these, one (as reported above) had no lavender tints. Seven others only mention a lavender "volva" without indicating whether the colour was seen on the pileus, the basal bulb, or both. Since the lavender tint could have been only on the bulb's rim, such reports could be a misinterpretation of normal pinkish colouration often seen there. Therefore, I excluded the seven collections in question. The remaining collections bear Coker's numbers 390, 570, 590, 853, and 1432. Numbers 570 and 1432 are illustrated in plates in the protologue. What keeps me from designating a lectotype here is that I found annotations in two different packets indicating that each had been selected as a lectotype. At the deadline for this review, I had not been able to find whether either collection was formally designated as a lectotype in print. I am particularly interested in readers' help in tracking any publication that relates to the present taxon with A.M. Peterson as an author.

⁸ *Amanita rubescens* var. *alba* Coker, *J. Elisha Mitchell Scient. Soc.* **33**(1-2): 62, pl. 67 (1917): lectotype: U.S.A.: North Carolina, Battle's Grove, under oaks, 3 vii 1916, W. C. Coker 2355 (NCU – *lectotypus hic designatus*). A second collection of the same date (incorrectly dated in protologue), W. R. Totten 2346 (NCU) (collection site: "woods by road to Scott's Hole") is not selected because it consists of a single basidiome in poor condition.

The designation of a neotype for *A. ponderosa* f. *valens* is incorrect because there exists original material that should have been selected as a lectotype given the authors' opinion (and mine as well) that the herbarium of Gilbert must be assumed lost. The lectotype should be the photographic montage by Josserrand that appears as tab. 31 in the illustrations making up the third fascicle of (E.-J. Gilbert 1940-41).⁹

The selection of a plate as a neotype of *A. virosa* is incomprehensible. A neotype for *A. virosa* should be a well-documented, well-dried collection of multiple specimens of varying maturity from the original collecting area of the species' author (i.e. Fries). The idea that a neotype should be a plate in order to achieve a base for determining colour is absurd given the availability of colour standards for use in making descriptions. Also, photographs or paintings can be made of a neotype collection. Again one wishes time had been taken by the authors to communicate actively with northern European mycologists. Similar comments apply to six other neotypifications by the designation of plates: *A. excelsa* (the pileus colour of the "neotype" does not match that in any of the included modern photographs of the taxon), *A. phalloides* var. *alba*, *A. regalis*, *L. delicata*, *L. glioderma*, and *L. illinita*. Personally, I cannot accept these neotypifications although I recognize that changing them may require formal proposals to the Committee for Fungi.

The rejection of a long accepted neotype is surprising. The authors tacitly reject the neotypification of *A. muscaria* by Jenkins & Petersen (1976) because at least some specimens of the collection bore yellow volval material. They argue that because Singer (1958), in his brief protologue of *A. muscaria* subsp. *flavivolvata*, compared the American taxon to yellow-volvate specimens of the European type subspecies, the latter European specimens are examples of the American taxon. Apparently no American material was reviewed; no comparison was made. The authors' assumption is illogical, false, and not to be followed.

Supraspecific taxa

Seventeen new supraspecific taxa are proposed. The usage of "series" is consistent with the *Code*, but the complexity of the authors' "series" concept spans the range from subsection as used by Bas (1969) to the unattributed 'stirpes' in the same work. They reduce, or propose to reduce, all Bas' (1969) subsections of sect. *Lepidella* to series. A short statement regarding these changes (p. 456, substantially repeated on p. 458 and referenced again on p. 511) states that since molecular studies may make sect. *Lepidella* appear polyphyletic in the future, they should reduce the ranks of the sectional names used by Bas now. Their proposal would leave no names (and no structure) whatsoever at subsectional rank in sect. *Lepidella* (or *Roanokenses*). The entire justification is: "Pour notre part, dans l'attente de résultats suffisants permettant de trancher, nous avons choisi, pour des raisons de commodité, de conserver les coupures de Bas au rang des séries, . . ." (p. 456). I find no reason to make the proposed alterations.

There is inconsistency in the usage of "series" in the treatment of sect. *Amanita*, where small groupings that might be more appropriately treated as stirpes are proposed as series.

⁹ *Amanita lepiotoides* f. *valens* E.-J. Gilbert, in Bresadola, *Icon. Mycol.* **27**(1): 291 (1941); lectotype: E.-J. Gilbert, *loc. cit.*: tab. 31 (a black and white photograph taken by Josserrand – *lectotypus hic designatus*).

The remaining three sections of subg. *Lepidella* (per Corner & Bas and subsequent writers prior to the present work) are reduced in rank and arranged in a nested manner. The resulting problems are similar to those with regard to the book's title: information from early molecular research is taken as definitive; morphological data is not taken into account; and subsequent molecular research supportive of a different phylogeny apparently appeared too late to impact the book. In a rarely cited portion of Bas (1969), he projected that, sect. *Lepidella* aside, the section basal to the remainder of subg. *Lepidella* would be sect. *Amidella*. With less certainty, Bas projected sections *Phalloideae* and *Validae* as having arisen from an ancestor or ancestors in sect. *Amidella*. Recent molecular work seems to support this view (Hallen, Adams & Tulloss unpubl.). At any rate, sect. *Amidella* is currently perceived more nearly basal than sect. *Phalloideae* (Zhang et al. 2004, Hallen et al. unpubl.) on both molecular and morphological grounds. The present work's arrangement of its equivalents of the Corner & Bas sections *Amidella*, *Phalloideae*, and *Validae*, is insufficiently supported by current literature and on-going research and is probably a misdirection.

Ranks and names aside, I agree that Neville & Poumarat are justified in separating the taxa most closely related to *A. ovoidea* (their series *Ovoidea* p.p.) from those most closely related to *A. volvata* (their series *Amidella*). On the other hand, it seems inappropriate to include *A. gilbertii* in series *Ovoidea*; this species appears to be closer phenetically and phylogenetically to sect. *Lepidella* (particularly, subsect. *Limbatulae*).

Further, with the possible exception of sect. *Amidella*, I am concerned that too few of the world's taxa are treated to justify such large changes in *Amanita* systematics. Familiarity with *Amanita* taxa of other continents suggests much is to be learned from their ill-known or undescribed taxa.

Specific and infraspecific taxa

I am pleased to see *A. cinerea* Bres. 1881 (nom. illegit.) receive a valid name (*A. bresadolana* nom. nov.).

The authors propose 16 new taxa at infraspecific ranks, i.e. varieties, forms, and subforms. Four names are provisional, and 12 are validly published.

What criteria are used to argue for any given infraspecific rank? The authors say they were driven not by the number of independent characters separating an infraspecific taxon from the type (a convention of Bas that is utilized widely by other contemporary researchers of *Amanita*), but by a desire to have the least 'incoherence', as opposed to what the author's call the satisfaction of 'pure logic'. While they have avoided logic at times, the result is unfortunately not always coherent or comprehensible. In Bas' system, a subform would have less than one character differentiating it from a species' type. Hence, in that system, there can be no subforms. There are three subforms from the authors' previous work retained here for *A. strobiliformis* (2) and *A. echinocephala* (1); their only description is in a key. I suppose in error, a nomenclatural synonym of one of the retained subforms, *A. solitaria* subf. *bicollariata*, is cited (correctly in my view) as a synonym of *A. echinocephala*.

Unfortunately, some of the infraspecific names proposed or otherwise accepted appear to be based on aged, distorted, sunburned, depigmented, diseased, or otherwise atypical specimens. Another facet of this problem appears in the book: While readers are advised of the possibility that some names could have been based on diseased material (e.g. *A.*

aminoaliphatica), the same possibility is several times not considered when examining other names, including some proposed as new.

Miscellaneous

It would be helpful if there were summary tables listing names and taxa that have been accepted and those that have been placed in synonymy or otherwise cast out of accepted use. Such a table would be particularly helpful if it contained page numbers on which nomenclatural decisions are proposed (e.g. in synonym lists). The abbreviations used for authors' names in citations are inconsistent, even in separate references to a single species, and such citations are provided repeatedly for the same species unnecessarily. If entries for taxa (which include synonymy) are insufficient to provide all pertinent author citations, it might have been better to combine these into a single table or just include them in the index. Within the text, such citations should be limited to the headings for descriptions of accepted taxa and associated lists of synonyms. Finally, an excessive number of exclamation points dot this book, usually indicating some (apparently) surprising fact or a "gotcha" aimed at some earlier author. After carefully reading hundreds of pages, this idiosyncrasy became irritating.

The planned companion volume

I have concerns about the proposed companion volume. First, I hope the text will be peer-reviewed by both European and non-European specialists on the group. This will not be an easy task for a work that is likely to be as large as, or larger than, the present one. A review of good quality may delay publication by a year, if not more; and I realize this may be problematic for the publisher. However, an extended period of usefulness for a review-enhanced book should be of value. Second, if the authors continue to cast aside the methodologies specifically developed to deal with sect. *Vaginatae* sensu Corner & Bas (1962), they may have considerable difficulties that have not been foreseen; and they may produce descriptions that cannot be compared with those produced in recent times by Yang, Tulloss, and their co-authors — a tragedy for *all* students of *Amanita*, considering the considerable time and effort Neville & Poumarat will have to expend to produce the companion volume. Finally, I urge the authors not to continue avoiding the clutches of 'pure logic' and to avoid changes in established names. Their undeniable urge to produce a massive work of science cannot be damaged by nomenclatural conservatism and should compel them to don the supposed straitjacket of logic that, in fact, frees one to obtain insight and truth.

Acknowledgments

I am grateful to C. Bas, M. Kuo, J. E. Lindgren, M. A. Tulloss, and Z. L. Yang who read this review in one or more stages of development and provided me with their valued comments. I am particularly grateful to the book review editor, D. L. Hawksworth, for his patient and attentive reading and rereading of my manuscript as well as for a great deal of sound advice to someone who had never in his life dreamed of reviewing a 1000+ page book.

Bas C. (1969) Morphology and subdivision of *Amanita* and a monograph on its section *Lepidella*. *Persoonia* 5: 285-579.

Bas C. (2000) Una vision più ampia sulle *Amanita*. *Bolletino del Gruppo Micologia G. Bresadola*, n. ser. 43(2): 9-12.

Corner EJH, Bas C. (1962) The genus *Amanita* in Singapore and Malaya. *Persoonia* 2: 241-304.

- De Candolle, A. P. & Duby, J. E. (1830) *Plantae cellulares seu Acotyledoneae*. Botanicon Gallicum seu synopsis plantarum in Flora Gallica descriptarum (A. P. De Candolle) 2: 545-1068. 2nd edn. Paris: Bouchard-Huzard ou Desray.
- Gilbert E.-J. (1940-41) *Amanitaceae*. Iconographia Mycologica **27**(Suppl. 1, 1-3): i-xx, 1-427.
- Jenkins DT. (1977) A taxonomic and nomenclatural study of the genus *Amanita* section *Amanita* for North America. *Bibliotheca Mycologica* **57**: 1-126.
- Jenkins DT, Petersen RH. (1976) A neotype specimen for *Amanita muscaria*. *Mycologia* **68**: 463-469.
- Kotilová-Kubičková L. (1982) Occurrence of amyloid substance in the plasma in hyphae of basidiocarps of some *Amanita* species (*Agaricales*). *Česká Mykologie* **36**: 114-117.
- Marr CD. (1979) Laccase and tyrosinase oxidation of spot test reagents. *Mycotaxon* **9**: 244-276.
- Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clemençon H Miller Jr OK. (2002) One hundred and seventeen clades of euagarics. *Molecular Phylogenetics and Evolution* **23**: 357-400.
- Singer, R. (1958) ["1957"] *Fungi mexicani, series prima - Agaricales*. *Sydowia* **11**: 354-37.
- Tulloss RE. (1998) ["1997"] Provisional world key to species closely related to *Amanita hemibapha* with notes on the slender Caesar's mushrooms of eastern North America. *McIlvainea* **13**: 46-53.
- Tulloss RE. (2000a) Le *Amanita* del mondo: bellezza, pericolo a diversità. *Bolletino del Gruppo Micologica G. Bresadola*, n. ser. **43**(2): 31-21.
- Tulloss RE. (2000b) Note sulla metodologia per lo studio del genere *Amanita* (*Agaricales*). *Bolletino del Gruppo Micologica G. Bresadola*, n. ser. **43**(2): 41-59.
- Yang ZL. (1997) Die *Amanita*-Arten von Südwestchina. *Bibliotheca Mycologica* **170**: 1-240.
- Zhang LF, Yang JB, Yang ZL. (2004) Molecular phylogeny of eastern Asian species of *Amanita* (*Agaricales, Basidiomycota*): taxonomic and biogeographic implications. *Fungal Diversity* **17**: 219-238.

RODHAM E. TULLOSS

P. O. Box 57, Roosevelt, New Jersey 08555-0057, USA

Amanitales, Russulales. By Vincentas Urbonas. 2001. UAB "Valstiečių Laikraštis", Laisvės pr. 60, 2056 Vilnius, Lithuania. [*Mycota Lithuaniae*, Vol. 8 (4).] Pp. 224, figs 33, col. pl. 32. ISBN 9986 847 43 5. Price: Not indicated.

This work, volume 8 (4) of the *Mycota Lithuaniae*, is dedicated to the orders *Amanitales* and *Russulales*. The part on *Amanitales* consists of 47 pages and that on *Russulales* 119 pages. The text is in Lithuanian, but at the end, there is an extensive English summary (24 pages) including dichotomous keys in English to all the species described in the book. This is followed bibliography occupying four pages.

The book is conceived in a classical manner, in the chapters on *Amanitales* and *Russulales*, complete description of the families, genera, species are provided with the most important synonyms, common names, and ecological information. In the order *Amanitales*, the families *Amanitaceae* with *Amanita* (17 species) and *Limacella* (3), and *Pluteaceae* with *Volvariella* (10) and *Pluteus* (22) are described. The order *Russulales* includes the *Russulaceae* represented by *Lactarius* (53) and *Russula* (72). The total number of species described is 177.

I especially want to stress the value of the colour photographs, generally well reproduced, and the colour iconography of several species, as well as the drawings of

the main microscopic characters (pileipellis, spores, and cystidia). This information will be very useful in understanding the taxonomic interpretations of the author.

In short, the information compiled in this book is important, and will be basic for subsequent taxonomic studies in the region where these two orders attract so much mycological, ecological, toxicological, and culinary interest.

GABRIEL MORENO

*Departamento Biología Vegetal, Universidad de Alcalá
Alcalá de Henares, ES-28871 Madrid, Spain*

Rúsculas Europeas: Introducción al conocimiento y determinación de las

Rúsculas. By Alfonso de Mena Calvet. 2004. Published by the author. [Address not supplied.] 2 vols. Price: € 67. [See www.telefonicas.net/web2/rillmenamepa/Bolets/.]

[Review copy refused by the publisher, implying that the work does not merit coverage in *Mycotaxon*.]

Cortinarius in Sweden. Karl Soop. January 2004. 9th revised edn. Editions Scientrix, Karl Soop, Djustäppv. 23, SE-792 90 Sollerön, Sweden. Pp. 102, figs 96, col. pl 24. ISBN 91 974803 1 2. Price: € 45.

Until very recently the *cortinari* could have been seen as a rather neglected group, with extensive up to date treatments being rather thin on the ground, with the exception of such coverage as that afforded by Breitenbach & Kränzlin (2000) for Switzerland. This is not difficult to understand given the complexity and diversity of the group in Europe. This revised edition of *Cortinarius in Sweden* arrives at a time when interest in this notoriously difficult group seems to have taken a turn for the better. In addition to the recent publication of the ongoing *Cortinarius Flora Photographica*, *Cortinarius in Sweden* proves that the group have not been neglected at all, and is at an affordable price. The book describes 228 taxa and references 148, with 96 colour plates of taxa rarely, or never previously, pictured in colour. Given that the book is printed on matt paper, they are reproduced rather well. This is a nice idea and very useful, but still means that those becoming interested in this group will have to be in possession of other, possibly more expensive publications that have colour pictures of the more common taxa. (That is for those individuals who wish to have colour pictures as an aid toward identification, I myself for one.)

The book is in two parts with a schematic key and the descriptions of species. Firstly, a useful explanation is given on the layout of the descriptions, and the chemicals that various subgenera and taxa react to. The schematic key gives the user a choice of descriptive characteristics of the various subgenera belonging to *Cortinarius*, namely *Dermocybe*, *Cortinarius*, *Sericeocybe*, *Phlegmacium*, *Myxacium* and *Telamonia* (the larger and smaller species, with separate keys) with reference given to each subgenus throughout each separate key. The author usefully, and rightfully, points out in the introduction that due to recent molecular work carried out on subgenus *Sericeocybe*, the majority of the taxa therein belong to subgenus *Telamonia*, and that *Sericeocybe* has been kept here for practical reasons.

As I have written this review at the beginning of spring, I haven't had the opportunity of testing the key, and therefore feel it presumptuous to comment on its usefulness.

Having said that, the key appears to have a good balance of information that enables the user to work through the 'keying out' of particular taxa.

Following the keys are descriptions of the species, which as the author points out are like keys themselves with each subgenus broken down into their respective sections and given a group number 1, 2, 3, etc., with information highlighted in bold on characteristics, and host partners for the relevant taxa. Plate and figure numbers are given for taxa with colour pictures. The descriptions are easy to follow and fairly brief, with one or two lines per heading. Added to the usual, cap, stem, gill and flesh details are useful notes on the veil and cortina. Microscopic characteristics, such as spore and cystidium size and cystidium shape, are also given. It would have been even more useful had drawings of spores and cystidia been included, but then the book probably would have been more expensive as a result. Coded information on locations for the rarer taxa are given and supported by a very useful list of locations at the back of the book should an individual wish to seek these out. An exhaustive reference section for further reading is also included which has corresponding codes in the descriptive text.

Having discovered that this book was available, and at such a good price, I snapped up a copy immediately¹⁰ and feel that it will be a most useful tool in keying out some of those difficult cortinari. For those who are embarking on a journey into this fascinating and colourful group, and for those already some way down the line, *Cortinarius in Sweden* is a clear, useful, and very welcome addition to a trend that I hope continues to flourish to enable a better understanding of the group.

Breitenbach J, Kränzlin F (Eds). (2000) Fungi of Switzerland. Vol. 5. *Agarics*, 3rd part *Cortinariaceae* (lamellate). Lucerne: Verlag Mykologia.

ANDY S. OVERALL

Flat 2, 39 North End Road, Golders Green, London NW11 7RJ, UK

Neotropical Polypores. Part 1. Introduction, Ganodermataceae & Hymenochaetaceae. By Leif Ryvarden. 2004. Fungiflora, P. O. Box 95, Blindern, N-0314 Oslo, Norway. [Synopsis Fungorum No. 19.] Pp. 229. ISBN 82 90724 30 6. Price: € 25, NOK 200.

This book gives an up to date review on these two very important well-represented families in the neotropics. The rest of the polypores are to be published in two forthcoming volumes. As it has now become clear, these areas are very rich in polypores, but there is a desperate lack of keys, manuals and species descriptions that make the job of identifying these fungi almost impossible for foreign and local mycologists working in these groups or in wood decomposing fungi.

The first part of this new book gives a general introduction much in style of that provided in *North American Polypores* (Gilbertson & Ryvarden 1986) with useful general information on both macro- and micromorphology, and with each term explained and illustrated. There is as well a section on practical advice for the collection and determination of polypores. This volume covers the neotropical species of *Amauroderma* (21 species), *Ganoderma* (20), *Haddowia* (1), *Aurificia* (1), *Coltricia* (9), *Cyclomyces* (3), *Inonotus* (25), *Phellinus* (60), and *Phylloporia* (6). All of these

¹⁰ The publisher had declined to send a complimentary copy for review to *Mycotaxon* [Ed.].

are provided with detailed descriptions and are partly illustrated in 104 figures. Very useful is the fact that keys for the genera and species are provided. There are several species described as new to science: in *Amauroderma* (2 species), *Ganoderma* (3), and *Phellinus* (4); in addition, three new combinations are made.

The description format and illustration styles are the same as in previous works from Fungiflora: *North American Polypores* (Gilbertson & Ryvarden 1986-87), *European Polypores* (Ryvarden & Gilbertson 1993-94), and a *Manual of the East Asian Polypores* (Nuñez & Ryvarden 2000-01). This standardization of style will permit the reader to compare different species. Genera and species are presented in alphabetical order without regard to relationships, facilitating its use.

This volume is a 'must' to anyone working on or with macrofungi in the neotropics, including systematic mycologists, forest pathologists, and amateurs.

Gilbertson RL, Ryvarden L. (1986-87) *North American Polypores*. 2 vols. Oslo: Fungiflora.

Nuñez M, Ryvarden L. (2000-01) *Manual of the East Asian Polypores*. [Synopsis Fungorum Nos. 13-14.] Oslo: Fungiflora.

Ryvarden L, Gilbertson RL. (1993-94) *European Polypores*. 2 vols. [Synopsis Fungorum No. 6.] Oslo: Fungiflora.

TERESA ITURRIAGA

Departamento Biología de Organismos
Universidad Simón Bolívar, Caracas, Venezuela

Polyporaceae s.l. By Annarosa Bernicchia. January 2005. Edizioni Candusso, Via Ottone Primo 90, I-17021 Alassio (Savona), Italy. [Fungi Europeaei Vol. 10. Pp. 808, col. pl. 343, figs. 292. ISBN 88 901057 5 5. Price: € 67.

Monographs devoted to the identification of *Aphyllphorales* s. lat. are very rare and, as a consequence, many older manuals and floras, often with outdated nomenclature, are still frequently used. The publication of this volume is therefore to be highly praised. It provides a monographic essay of the polyporoid fungal biodiversity, aimed to fully describe and document all the species of the pertinent group reported from Italy. The book, which is in Italian, is an important and valuable update of the previous *Polyporaceae s.l. in Italia* published in 1990 by the same author.

The *Polyporaceae* is not a monophyletic family and includes resupinate, poroid, and non-resupinate poroid *Aphyllphorales* s. lat. — indeed all types of fungi with pores (a tubular hymenophore) or pore-like derived structures in which the pore layer cannot be easily peeled off from the context. The book treats 271 species, gathered in the woods of continental Italy and especially in Mediterranean areas where the maquis and juniper scrub mycobiotas are still little known. Two out of these are described as new species: *Antrodia citrina* and *Antrodiella ichnusana*. Three genera, *Echinodontium*, *Favolaschia* and *Neolentiporus*, are reported as new for Italy and Europe, and 19 species are the first reports for Italy. One new combination is also made, *Oligoporus alni*.

The layout of the book is clearly organised. After a foreword and a preface, the book opens with a short chapter Fungi and Environment (by F. Moriondo), giving a general survey on fungal ecology, nutritional strategies, and associations of fungi with other organisms. The chapter 'Vegetation zones and belts in Italy' (by A. L. Zanotti) provides an outline of the Italian bio-phytogeographical zones, defined by a combination of

climatic, edaphic, floristic, ecological and phytosociological criteria, and altitudinal belts. The third chapter, General features of *Aphyllphorales*, is devoted to polypore micro- and macromorphology and is well illustrated by line drawings. The last chapter on Fungal species as environmental bioindicators (co-authored with A. Laganà) focuses on the role of macrofungi in environmental conservation, and in particular the indicator value of wood-inhabiting fungi for undisturbed forest sites, of ectomycorrhizal fungi for air pollution stress in forests, and of saprotrophic fungi for the duration of undisturbed grassland use. Some polyporoid species have proved to be very useful bioindicators for environmental quality as specific markers of old primeval boreal forests.

The fourth chapter gives a systematic overview of polyporaceous fungi (4 orders, 13 families and 78 genera) based on the system in the latest edition of *Ainsworth & Bisby's Dictionary of the Fungi* (Kirk et al. 2001) and followed by an alphabetically ordered list of the species described in the volume.

The final chapter consists of a traditional, dichotomous identification key to families and genera of polyporoid species. The key is based on microscopic features (hyphal system, presence of clamps, type and origin of cystidia, and chemical reactions) as well as on basidiome morphology (shape, type of hymenophore, and mode of attachment). The descriptions of the species (483 pages) constitute the main body of the monograph, since the profiles of 271 species are given, arranged alphabetically within each genus. All the species are fully described and put into perspective from systematic, ecological and distributional points of view. In addition, 229 species out of the 271 are illustrated by colour photographs (all gathered in an atlas at the end of the book). The original diagnoses are reported for almost all species, as well as the basionym, main synonyms, drawings and microscopic features. In addition to a full description in Italian, an English summary of the main diagnostic macro- and micromorphological characters is provided. All the keys, the general one to the genera included, are in both Italian and English. These features will surely add to the user-friendliness of the volume. Some species, widely distributed in Europe, but still not recorded in Italy, are described in the same detail, and a key to the worldwide species of *Echinodontium* is provided.

The book concludes with a (perhaps too short) glossary of mycological terms, a bibliography of essential books and publications, an impressive iconography (343 colour photographs), and a general index including scientific names mentioned in the volume.

Considering the wide scope of the book and its extensiveness, there are just a few inaccuracies or omissions to note. A general comment concerns the first introductory Chapters (1-3), which are disappointing, sketchy and overall rather dated. For example, data on the description of cultures of polyporoid fungi (including chemical tests, growth rate, hyphal characters, mating and nuclear behaviour), secondary metabolites, and biotechnological applications and ethnomycological uses, are missing or largely incomplete. A more detailed illustration of the biology of the group would have provided a better introduction to the species descriptions.

A second point meriting discussion is the rationale of the classification: the suprageneric taxa are presented in accordance with the system used in Kirk et al. (2001), while generic and specific concepts follow *European Polypores* (Ryvarden & Gilbertson 1993-94) and *Genera of Polypores* (Ryvarden 1991). Unfortunately, the author does

not offer a detailed explanation of the guidelines and of her personal contributions in order to justify her systematic construction.

A further discussion point is that the book can be seen as an example of a monograph dealing with an exclusively morphologically defined group. As a consequence, it does not follow the current trend of monographic treatments which combine molecular, biochemical, and micro- and macromorphological tools to provide a comprehensive view of the genera treated. Polyphasic ("blending") taxonomy is becoming the state-of-the art methodology in the systematic and phylogenetic treatment of fungi, from the perspective that none of these methods can stand on its own, and that all known characteristics should be considered.

We will present a few examples to support this view: the relation of *Sparassis* to *Laetiporus* and *Phaeolus* and of *Trichaptum* to *Hymenochaetales* (e.g. Hibbett & Donoghue 2001, Goes-Neto et al. 2002, Wang et al. 2004) as revealed by ultrastructural and molecular analysis are not pointed out; mitochondrial SSU rDNA sequence analyses have indicated that *Antrodia* is a heterogeneous genus (Kim et al. 2003) and that *Daedaleopsis tricolor* might be an ecotype of *D. confragosa* (Ko & Jung 1999); numerous characters from morphology, anatomy, sexuality, nuclear behavior, pigmentation, rDNA sequence data and ecology have suggested that *Phellinus* s. lat. and *Inonotus* s. lat. are both very heterogeneous (Fiasson & Niemelä 1984; Fischer 1996; Wagner & Fischer 2001, 2002); studies based on DNA data (Hibbett & Binder 2001, 2002; Moncalvo et al. 2002; Bodensteiner et al. 2004) and metabolite content (strobilurins) (e.g. Nicholas et al. 1997, Sauter et al. 1999) have highlighted that *Favolaschia* and some other poroid extra-European genera (*Dictyopanus*, *Filoboletus*, *Mycenoporella* and *Poromyceia*) are most closely related to *Mycena* and *Panellus*.

There are also many minor comments. In the species descriptions, *Albatrellus*, *Boletopsis* and *Inonotus* (*Onnia*) *tomentosus* are regarded as terricolous fungi and thus probably able to form mycorrhizas, but actually the ectomycorrhizas of *Albatrellus* and *Boletopsis* were already described in the 1990s (Agerer 1992, 1993, 1996a, b; Agerer & Klostermeyer 1996). A mycorrhizal association with *Pinus banksiana* and *Arctostaphylos uva-ursi* has been reported for *Coltricia perennis* (the type species of the genus) (Danielson 1984), but since then, there have been no further studies on this aspect. Further, the production of basidiomes on living trees or rotting wood is not necessarily indicative or predictive of parasitic or saprotrophic nutrition (Rayner et al. 1985; Henkel et al. 2000).

For many species, the names of anamorphs are not given: for example those of *Fistulina hepatica* (i.e. *Confistulina hepatica*), *Postia floriformis* (i.e. *Ptychogaster rubescens*), and *Postia rennyi* (i.e. *Ptychogaster citrinus*). In other cases they are mentioned, but not with the scientific names: as for *Inonotus rickii* (i.e. *Ptychogaster cubensis*) and *Abortiporus biennis* (i.e. *Sporotrichopsis terrestris*).

In conclusion, and irrespectively of these comments, the volume deals with a huge assemblage of organisms, the classification of which is now in the course of being reshaped and which are attracting increasing interest. The book is written in a fascinating way, which will surely stimulate readers to engage in the study of polyporaceous fungi. Given that the volume does aim to be an all-encompassing monograph, but mainly an identification and iconographic manual, it can be recommended as a valuable tool and

source of information for mycologists, technicians, biologists and biology students, and also for those loving beautiful forms of nature. As is usual for Edizioni Candusso publications, the paper and the hardcover are of excellent quality and the work is carefully edited.

- Agerer R. (1996a) *Albatrellus ovinus* (Schaeff.: Fr.) Kotl. & Pouz. + *Picea abies* (L.) Karst. Descriptions of Ectomycorrhizae **1**: 23-28.
- Agerer R. (1996b) *Albatrellus ovinus*. In Colour Atlas of Ectomycorrhizae (R Agerer, ed.): pl. 91. Schwäbisch Gmünd: Einhorn Verlag..
- Agerer R, Klostermeyer D, Steglich, W, Franz, F, Acker G. (1996) Ectomycorrhizae of *Albatrellus ovinus* (Scutigeraceae) on Norway spruce with some remarks on the systematic position of the family. Mycotaxon **59**: 289-307.
- Agerer R. (1992) Studies on ectomycorrhizae XLIV. Ectomycorrhizae of *Boletopsis leucomelaena* (Thelephoraceae, Basidiomycetes) and their relationship to an unidentified ectomycorrhiza. Nova Hedwigia **55**: 501-518.
- Agerer R. (1993) *Boletopsis leucomelaena*. In Colour Atlas of Ectomycorrhizae (R. Agerer, ed.): pl. 75. Schwäbisch Gmünd: Einhorn Verlag..
- Bodensteiner P, Binder M, Moncalvo J.-M, Agerer R, Hibbett DS. (2004) Phylogenetic relationships of cyphelloid homobasidiomycetes. Molecular Phylogenetics and Evolution **33**: 501-515.
- Danielson RM. (1984) Ectomycorrhizal associations in jack pine stands in northeastern Alberta. Canadian Journal of Botany **62**: 932-939.
- Fiasson JL, Niemelä T. (1984) The *Hymenochaetales*: a revision of the European poroid taxa. Karstenia **24**: 14-28.
- Fischer M. (1996) On the species complexes within *Phellinus*: *Fomitiporia* revisited. Mycological Research **100**: 1459-1467.
- Goes Neto A, Loguerico Leite C, Guerrero RT. (2002) Molecular phylogeny of tropical *Hymenochaetales* (Basidiomycota). Mycotaxon. **84**: 337-354.
- Henkel TW, Aime MC, Miller SL. (2000) Systematics of pleurotoid *Russulaceae* from Guyana and Japan, with notes on their ectomycorrhizal status. Mycologia **92**: 1119-1132.
- Hibbett DS, Binder M. (2001) Evolution of marine mushrooms. Biology Bulletin **201**: 319-322.
- Hibbett DS, Binder M. (2002) Evolution of complex fruiting-body morphologies in homobasidiomycetes. Proceedings of the Royal Society of London, B, Biological Sciences **269**: 1963-1969.
- Hibbett DS, Donoghue MJ. (2001) Analysis of character correlations among wood decay mechanisms, mating systems, and substrate ranges in homobasidiomycetes. Systematic Biology **50**: 215-242.
- Kim SY, Park SY, Ko KS, Jung HS. (2003) Phylogenetic analysis of *Antrodia* and related taxa based on partial mitochondrial SSU rDNA sequences. Antonie van Leeuwenhoek **83**: 81-88.
- Kirk PM, Cannon PF, David JC, Stalpers J. (2001) Ainsworth and Bisby's Dictionary of the Fungi. 9th edn. Wallingford: CABI Publishing.
- Ko KS, Jung HS. (2003) Molecular phylogeny of *Trametes* and related genera. Antonie van Leeuwenhoek **75**: 191-199.
- Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H, Miller OK jr (2002) One hundred and seventeen clades of euagarics. Molecular Phylogenetics and Evolution **23**: 357-400.
- Nicholas GM, Blunt JW, Cole ALJ, Munro MHG. (1997) Investigation of the New Zealand Basidiomycete *Favolaschia calocera*: revision of the structures of 9-methoxystrobilurins K and L, strobilurin D and hydroxystrobilurin D. Tetrahedron Letters **38**: 7465-7468.
- Rayner ADM, Watling R, Frankland JC. (1985) Resource relations-an overview. In *Developmental*

- Biology of Higher Fungi* (D Moore, LA Casselton, DA Wood & JC Frankland, eds): 1-40. Cambridge, UK: Cambridge University Press.
- Ryvarden L. (1991) *Genera of Polypores: nomenclature and taxonomy*. [Synopsis Fungorum No. 5.] Oslo: Fungiflora.
- Ryvarden L, Gilbertson RL. (1993) European Polypores. Part 1. *Abortiporus–Lindtneria*. [Synopsis Fungorum No. 6.] Oslo: Fungiflora.
- Ryvarden L, Gilbertson RL. (1994) European Polypores. Part 2. *Meripilus–Tyromyces*. [Synopsis Fungorum No. 7.] Oslo: Fungiflora.
- Sauter H, Steglich W, Anke T. (1999) Strobilurins: evolution of a new class of active substances. *Angewandte Chemie, International Edition* **38**: 1329-1349.
- Wagner T, Fischer M. (2001) Natural groups and revised system for the European poroid *Hymenochaetales* (Basidiomycota) supported by nLSU rDNA sequence data. *Mycological Research* **105**: 773-782.
- Wagner T, Fischer M. (2002) Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetic relationships of allied genera. *Mycologia* **94**: 998-1016.
- Wang Z, Binder M, Dai YC, Hibbett DS. (2004) Phylogenetic relationships of *Sparassis* inferred from nuclear and mitochondrial ribosomal DNA and RNA polymerase sequences. *Mycologia* **96**: 1015-1029.

ALFREDO VIZZINI & PAOLA BONFANTE

Dipartimento di Biologia Vegetale dell'Università

Viale Mattioli 25, I-10125 Torino, Italy

Lichen-forming fungi

Les Macrolichens de Belgique, du Luxembourg et du Nord de la France: Clés de Détermination. By Emmanuël Sérusiaux, Paul Diederich & Jacques Lambinon. 15 August 2004. Musée National d'Histoire Naturelle, 25 rue Munster, L-2160 Luxembourg. [Ferrantia No. 40.] Pp. 192, col. pls, maps. ISSN 1682-5519. Price: € 10.

When I was taking my first steps in lichenology in the 1960s, Lambinon's (1961) keys to and photographs of Belgian macrolichens were very helpful when little else was readily available in Europe. A second edition was prepared later in the decade, almost double the length of the first (Lambinon 1968), a new checklist for Belgium and Luxembourg has been issued (Diederich & Sérusiaux 2000; see *Mycotaxon* **86**: 498-499, 2000), but no third edition of the identification guide has been released. This is rectified here, and how splendidly, by collaboration with the authors of the checklist.

The new volume starts with an overview of lichen structure, biology and ecology and keys to genera, and then keys to species within them as did the earlier works, but then there is much more. There are entries for each of the 327 species included, with selected synonyms and notes on ecology and distribution, and further observations. Detailed coloured distribution maps are provided for 241 of the species, with three sizes of red dots relating to different age categories of the records (<1914, 1914-72, and >1972), and 125 species are illustrated by superb colour photographs.

The taxonomy is up to date, but there are the odd decisions which grate, such as the treatment of *Parmelia discordans* as a subspecies, and the premature acceptance of some of the parmelioid lichen segregates (e.g. *Neofuscelia*, *Rimelia*) and *Lobarina*. But

I was pleased to see the true *Bryoria subcana* in colour (p. 39), I believe for the first time in print, and where the colour differences with *B. fuscescens* can be compared with the picture of that species on the facing page.

Especially welcome is that the text can be downloaded free through the Internet (<http://www.naturmusee.lu/recherche/ferrantia/>). I think this a 'first' for a lichen identification guide also available in print.

Diederich P, Sérusiaux E. (2000) The Lichens and Lichenicolous Fungi of Belgium and Luxembourg. Luxembourg: Musée National d'Histoire Naturelle.

Lambinon J. (1961) Les lichens. Les Naturalistes Belges 42: 173-246.

Lambinon J. (1968) Les lichens. Les Naturalistes Belges 49: 205-280, 449-558. [Re-issued with independent pagination in 1969.]

Key to the Genera of Australian Macrolichens. By Patrick M. McCarthy & William M. Malcolm. 2004. Australian Biological Resources Study, G. P. O. Box 787, Canberra ACT 2601, Australia. [Flora of Australia Supplementary Series No. 23.] Pp. viii + 63, col. figs 90. ISBN 0 642 56834 0. Price: AS \$ 33.

This splendidly produced ring-bound book provides keys to 135 genera which emphasize characters that are visible with a hand lens. Where genera are keyed out, more detailed descriptions are provided along with notes on the ecology, distribution, the number of species in the genus, and references to literature. Especially welcome are the superb colour photographs of 90 species, testifying once again to William Malcolm's expertise, although it would have been helpful to have fuller legends with magnifications given. This is specially so when the photographs illustrate, for example, the underside or margin of a foliose thallus where it is of diagnostic value, the close-up of an apothecium on a thallus where no thallus margins are evident, or of an unusual habitat (*Xanthoparmelia mougeotina* on a glass bottle). The photographs need to be used as back up to the keys, and should not be the first port of call when attempting an identification. Notwithstanding these minor remarks, this will be a major boost to those starting to explore Australian macrolichens for the first time.

This work supplements that on apothecial crustose lichens published earlier (Lumbsch et al. 2001; see *Mycotaxon* **85**: 481, 2003), and both merit a wide circulation amongst amateur naturalists in particular. A third contribution in this series devoted to pyrenocarpous lichen genera would be welcome even though such a key has been prepared before (McCarthy 2001; see *Mycotaxon* **83**: 505-506, 2002) as it would then be more easily accessible to the non-professional.

Lumbsch HT, McCarthy PM, Malcolm WM. (2003) Key to the Genera of Australian Lichens: Apothecial Crusts. [Flora of Australia Supplementary Series No. 11.] Canberra: Australian Biological Resources Study.

McCarthy, P. M. (2001) Key to the genera of crustose pyrenocarpous lichens in Australia. *Flora of Australia* 58A: 197-206..

Flora Liqueológica Ibérica: *Peltigerales*: *Lobariaceae*, *Nephromataceae*, *Peltigeraceae*. By Ana Rosa Burgaz & Isabel Martínez. 2003. Sociedad Española de Liqueología, c/o Departamento de Biología Vegetal (Botánica), Facultad de Biología, ES-30071 Murcia, Spain. Pp. 61, figs 10, maps 1. ISSN 1696-0513. Price: € 10.

This publication, which is entirely in Spanish, is the first product of an initiative involving 29 Spanish lichenologists. Their aim is to publish accounts of lichens in the Iberian Peninsula and Balearic Islands (but not the Canary Islands) group by group as they are completed. The present volume deals with the genera *Lobaria* (4 species), *Nephroma* (5), *Peltigera* (24), *Pseudocyphellaria* (2), *Solorina* (5), and *Sticta* (4). Descriptions of the order, families and genera precede keys to the species, and the species accounts include places of publication of accepted names and synonyms, type collections (many checked by the authors), references to published illustrations, a detailed description, notes on habitat and distribution. While no distribution maps are provided, something difficult in the absence of a national recording scheme, the provinces in which the species occur are indicated.

An especial feature is the detailed full-page line drawings prepared by J. Castillo showing diagnostic features such as venation patterns on the undersides of thalli, isidium, and rhizine types. These carefully executed drawings make this work of value to those struggling with *Peltigera* in particular even if not familiar with Spanish. The treatment of the largest genus, *Peltigera*, is largely based on the critical revision of the second author (Martínez, 1999; see *Mycotaxon* 78: 509, 2001), which included maps but no illustrations of the species; the two works are therefore complementary and best used in conjunction.

A sound start to the series, but why have 'Flora' in the title when dealing with fungi that are certainly not plants? Old practices die hard, but to launch a series with such a title in 2003 is regrettable. It would have been much more appropriate, to entitle it either 'Líquenes de Iberia,' or better 'Hongos liquenizados de Iberia' . . .

Martínez Moreno MI. (1999) Taxonomía del género *Peltigera* Willd. (ascomycetes liquenizados) en la Península Ibérica y estudio de sus hongos liquenícolas. *Ruizia* 15: 1-200.

Catalogue of Australian Lichens. By Patrick M. McCarthy. 2003. Australian Biological Resources Study, G. P. O. Box 787, Canberra ACT 2601, Australia. [Flora of Australia Supplementary Series No. 19.] Pp. 238, figs 1. ISBN 0 642 56827 8. Price: AS \$ 36.

This is the seventh checklist of Australian lichens to have appeared since 1972 (Weber & Wetmore 1972). These document the resurgence of interest in Australian lichens, and also incorporate increasing amounts of data. For example, the penultimate (Filson 1996) was the first to include the places of publication of both accepted names and synonyms, continued in the latest. A first in this new checklist is the citation of key literature references at the end of each generic listing. All these seven checklists have included indications of the states from which species are known, but not all total the species. The last to give totals was that of McCarthy (1991) where 2494 taxa were accepted, and that figure has swelled to 3138 in this new checklist, an increase of 26 %. Of especial interest is the proportion of endemics, now standing at 1055 species, 34 % of the total. This last figure is a proportion that I am sure will rise as more species are examined critically, especially using molecular techniques, and crustose species receive more attention. Queensland is the state currently showing the highest proportion of endemics, 321 (20 %) of the 1621 species known from the state. In addition, there are substantial numbers of names of uncertain application and *nomina nuda* that still await modern reassessments and which are listed separately here, of which a significant proportion may

well eventually prove to merit recognition. While the genera are treated alphabetically, their assignments to families are given and there is also a synoptic summary of genera by families.

Filson RB. (1996) Checklist of Australian Lichens and allied Fungi. [Flora of Australia Supplementary Series No. 7.] Canberra: Australian Biological Resources Study.

McCarthy PM. (1991) Checklist of Australian Lichens. 4th edn. Melbourne: National Herbarium of Victoria.

Weber WA, Wetmore CM. (1972) Catalogue of the lichens of Australia exclusive of Tasmania. Beihefte zur Nova Hedwigia **41**: 1-137.

Les Champignons Lichénisés de Suisse. By Philippe Clerc. 2004. Bibliotek, Geobotanical Institute ETH, Zollikerstrasse 107, CH-8008 Zürich, Switzerland. [Cryptogamica Helvetica No. 19.] Pp. 320, figs 1, tables 6. ISSN 0257-9421. Price: CHF 96.

Despite Switzerland having been intensively studied by lichenologists since the early decades of the 19th century, this is apparently the first comprehensive checklist for the country to have been published since that of Stizenberger (1882-83) which treated 1343 species. In the new checklist, the total has grown relatively modestly to 1660 species placed in 273 genera. However, these totals mask a huge amount of change owing to revisions of species concepts and evaluations of synonymy. This is evidenced by the inclusion of cross-references to 4956 synonyms, and in addition 201 species are excluded for a variety of reasons.

The entries for accepted species are especially comprehensive and include information on districts from which they are included, biogeographical regions in which they occur, substrate, altitude, literature references, and in some cases remarks. Especially commendable is the inclusion of references to the full list of publications on which basis taxa are accepted for inclusion.

The taxonomic treatment is generally conservative, not even accepting some of the sounder based parmelioid segregates (e.g. *Parmelina*) and retaining *Usnea subfloridana* as distinct from *U. florida* despite molecular evidence to the contrary "principalement pour des raisons de conservation" (surely a non-sequitur if they are actually the same species). However, *Diplotomma* is accepted, and inclusive of *D. canescens*, and three new combinations are made: *Diplotomma hedinianum* (for *D. epipolium* auct.), *Lichinella heppii* (syn. *Omphalaria heppii*), and *Porpidia turgida* (syn. *Biatora turgida*).

This checklist, which has involved an enormous amount of scholarship and painstaking bibliographic work, means that, at last, Switzerland has a single key modern reference work to its lichens. This will provide a major stimulus to a resurgence of interest in lichenology in the country amongst professionals and amateurs alike, and also underpin the active lichen conservation programmes already underway.

Stizenberger E. (1882-83) Lichenes helvetici eorumque stationes et distributio. Bericht über die Tätigkeit der St Gallischen Naturwissenschaftlichen Gesellschaft **22**: 255-522, **23**: 201-327.

A Catalogue of Eastern Carpathian Lichens. By Sergey Ya. Kondratyuk, Lydmyla P. Popova, Anna Lackovičová & Ivan Pišút. 2003. M. H. Kholodny Institute of Botany, Tereshchenkivska Street 2, 01601 Kiev-MSP-1, Ukraine. Pp. 264, figs 2, tables 1. ISBN 966 608 408 2. Price: Not indicated.

This checklist is a counterpart to that on the lichens of the western Carpathians (Bielczyk et al. 2004; see *Mycotaxon* **90**: 485-486, 2004). It has parts in Poland, Romania, the Slovak Republic, and Ukraine, and the lichens of the Polish sector are also treated in Bielczyk (2003; see *Mycotaxon* **90**: 485-486, 2004). The eastern Carpathians checklist includes 1304 species in 292 genera, somewhat less than the 1817 species in 288 genera recorded in the western Carpathians. However, the totals are not strictly comparable as the eastern Carpathian list also includes lichenicolous fungi. The Ukrainian part of the eastern Carpathians has the most species recorded (1095 species), but the largest area in the region is the Romanian sector, which is as yet hardly explored lichenologically. An important difference in the two volumes is that here full details of the literature sources of records are provided, along with the name used in the publication if not that currently accepted, not just acronyms for the countries as in the western Carpathian compilation. Synonyms are cross-referenced at the end of each accepted genus. The contents are well presented, but the binding is poor; the board cover of the review copy started to separate just while paging through to prepare this notice.

While I am sure from my own brief visit to the Ukrainian part of the eastern Carpathians in 1991 that much still remains to be discovered in the region, it is pleasing to see what is known so thoroughly documented.

Bielczyk U (Ed.). (2003) The Lichens and allied Fungi of the Polish Carpathians – an annotated checklist. Kraków: W. Szafer Institute of Botany.

Bielczyk B, Lackovičová A, Farkas EE, Lőkös L, Liška J, Breuss O, Kondratyuk SYa. (2004) Checklist of Lichens of the Western Carpathians. Kraków: W. Szafer Institute of Botany.

Atlas of the Geographical Distribution of Lichens in Poland. Part 4. Edited by Urszula Bielczyk, Stanisław Ciesliński & Wiesław Fałtynowicz. 2004. Władysław Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31 512, Kraków, Poland. Pp. 110. ISBN 83 89648 20 2. Price: € 25.

This part continues at the increased size started with Part 3 (see *Mycotaxon* **89**: 221-222, 2004), has the same format for the maps, and again deals with the distribution of 20 species with incredibly detailed documentation on localities, voucher specimens, and literature sources. The species in this part belong to the genera *Arthonia* (1 species), *Caloplaca* (2), *Cladonia* (2), *Lecanora* (2), *Lepraria* (1), *Opegrapha* (1), *Placynthium* (3), *Schismatomma* (1), *Solorina* (1), *Thamnolia* (1), and *Vezdaea* (1). Eleven authors have contributed, and the text on each species is given first in English and then in Polish; this includes information on the ecology and status of the species, and it is clear that the authors are generally very familiar with the species they treat in the field.

I hesitate to suggest a major change in an established and excellent series, but I do wonder if the time has come to revise the date categories used for the mapped records. At present these are pre-1900, 1900-60, and post-1960. However, there have been significant changes in European lichen distributions and frequencies over recent decades, with the fall of sulphur dioxide and smoke pollution, the subsequent increase in nitrogen deposition in many areas, and now effects of climate change. Such movements will be masked by the present dot system, though I recognize that the information is in the record details and much could be painstakingly extracted given sufficient time. I do, however, suggest consideration be given to dividing the post-1960 category into two:

1961-1990 and post-1991. Whatever the decision on that point, this remark does not detract from the value of this continuing work for those concerned with the conservation and distribution of European lichens.

Nomenclatural novelties proposed in Mycotaxon, Volume 92

- Achlya achlyoides* (Coker & Alexander) Johnson & Seymour, p. 12
Achlya androgyna (Archer) Johnson & Seymour, p. 14
Achlya irregularis (Coker & Ward) Johnson & Seymour, p. 17
Achlya ornata Johnson & Seymour, p. 18
Achlya primoachlya (Coker & Couch) Johnson & Seymour, p. 20
Achlya pseudoachlyoides (Beneke) Johnson & Seymour, p. 22
Acrogenospora verrucospora Hong Zhu, L. Cai & K.Q. Zhang, p. 385
Aecidium melleriae Gjørø, p. 251
Aecidium senecionis-jacksonii Gjørø, p. 251
 Albuginomycetidae Thines, p. 453
 Albuginales Thines, p. 453
Aleurocystis gloeocystidiata Rajchenb. & Robledo, p. 318
Apiognomonia fakirovae Stoykov, p. 459
Aseroë floriformis Baseia & Calonge, p. 170
Cercospora bothriochloae U. Braun & Crous, p. 396
Cercospora phaseoli-lunati U. Braun & Crous, p. 396
Cercospora smilacigena U. Braun & Crous, p. 398
Cookeina globosa Douanla-Meli, p. 224
Corynespora donae X.G. Zhang & J.J. Xu, p. 433
Corynespora ficus-altissimae X.G. Zhang & J.J. Xu, p. 431
Corynespora flagellatum (S. Hughes) X.G. Zhang & M. Ji, p. 427
Corynespora phylloshureae X.G. Zhang & J.J. Xu, p. 433
Corynespora rhaps-humilisi X.G. Zhang & M. Ji, p. 425
Corynespora saccharume X.G. Zhang & Ch.K. Shi, p. 418
Corynespora tectonae X.G. Zhang & Ch.K. Shi, p. 418
Corynespora toonae X.G. Zhang & Ch.K. Shi, p. 421
Dacryopinax lowyi S. Sierra & Cifuentes, p. 244
Dactylella zhongdianensis J. Zhang & K.Q. Zhang, p. 290
Erysiphe pachypodii Lebeda, Mieslerová & Doležalová, p. 285
Exserohilum heteromorphum G. Y. Sun, p. 174
Flavocetraria minuscula (Elenkin & Savicz) Ahti, Poryadina & Zhurb., p. 202
Fomitiporia australiensis M. Fisch., J. Edwards, Cunningham & Pascoe, p. 93
Fusicladium artemisiae (H.C. Greene) K. Schub. & U. Braun, p. 57
Fusicladium astericola (Davis) K. Schub. & U. Braun, p. 59
Fusicladium baptisiae (H.C. Greene) K. Schub. & U. Braun, p. 62
Fusicladium caducum (Davis) K. Schub. & U. Braun, p. 65
Fusicladium coreopsisidis (H.C. Greene) K. Schub. & U. Braun, p. 67
Fusicladium monardae (H.C. Greene) K. Schub. & U. Braun, p. 71
Gyalecta canariensis van den Boom & Vězda, p. 255
Hemithecium balaghattensis Adawadkar & Makhija, p. 388
Hemithecium fulvescens Adawadkar & Makhija, p. 389
Hemithecium nagalandicum (K.P. Singh & G.P. Sinha) Adawadkar & Makhija, p. 390

- Hemithecium staigeriae* Adawadkar & Makhija, p. 390
- Kochmania* M. Piatek, p. 34
- Kochmania oxalidis* (Ellis & Tracy) M. Piatek, p. 34
- Lentinus bambusinus* T.K.A. Kumar & Manim., p. 119
- Leptolegnia hemihypogyna* Seymour, p. 1
- Microstoma camerunensis* Douanla-Meli, p. 231
- Monacrosporium multiseptatum* H.Y. Su & K.Q. Zhang, p. 194
- Oidium moluccanum* Liberato & R.G. Shivas, p. 377
- Ophiostoma allantosporum* (H.D. Griffin) M. Villarreal, p. 262
- Ophiostoma angusticollis* (E.F. Wright & H.D. Griffin) M. Villarreal, p. 262
- Ophiostoma coronatum* (Olchow. & J. Reid) M. Villarreal, p. 263
- Ophiostoma sejunctum* M. Villarreal, Arenal, V. Rubio & M. de Troya, p. 260
- Ophiostoma tenellum* (R.W. Davidson) M. Villarreal, p. 263
- Oxyporus ginkgonis* Y.C. Dai, p. 346
- Paecilomyces antarcticus* Bridge, M.S. Clark & D.A. Pearce, p. 217
- Paecilomyces stipitatus* Z.Q. Liang & Y.F. Han, p. 312
- Paecilomyces vinaceus* Y.F. Han & Z.Q. Liang, p. 312
- Parapyricularia brasiliensis* A. Silva, M.A.G. Barbosa, M. Menezes, M.P.S. Câmara, p. 44
- Passalora brandenburgeri* U. Braun & Crous, p. 399
- Passalora cardiostegiae* (B.H. Davis) U. Braun & Crous, p. 407
- Passalora lemnischea* (Cif.) U. Braun & Crous, p. 412
- Phialosporostilbe catenata* Sureshkumar, Sharath, Kunwar & Manohar., p. 279
- Phragmosporangium* Seymour, p. 6
- Phragmosporangium uniseriatum* Seymour, p. 8
- Piricaudiopsis indica* Sharath, Sureshkumar, Kunwar & Manohar., p. 280
- Platythecium commiscens* Adawadkar & Makhija, p. 392
- Platythecium occultum* Adawadkar & Makhija, p. 392
- Platythecium verrucoareolatum* Adawadkar & Makhija, p. 393
- Pronectria dillmaniae* Zhurb., p. 204
- Pronectria walkerorum* Zhurb., p. 206
- Protoachlya benekei* (Furtado) Johnson & Seymour, p. 23
- Protoachlya hypogyna* (Coker & Pemberton) Johnson & Seymour, p. 24
- Protoachlya mucronata* (Ziegler) Johnson & Seymour, p. 26
- Pseudocercospora clematidicola* U. Braun & Crous, p. 407
- Pseudocercospora forestierae* (E. West) U. Braun & Crous, p. 409
- Pseudocercospora garryae* (Harkn.) U. Braun & Crous, p. 410
- Pseudocercospora lepidagathidis* U. Braun & Crous, p. 399
- Pseudocercospora sambucigena* U. Braun, Crous & K. Schub., p. 400
- Pseudocercospora siparunae* D.J. Soares & R.W. Barreto, p. 274
- Pseudocercospora tinosporigena* U. Braun, p. 414
- Pseudocercospora xanthorhizae* U. Braun & Crous, p. 410
- Pucciniastrum hakkodaense* Y.M. Liang & Kakishima, p. 372
- Pustula* Thines, p. 454
- Pustula chardiniae* (Bremer & Petr.) Thines, p. 455

- Pustula hydrocotyles* (Petr.) Thines, p. 455
Pustula spinulosa (de Bary) Thines, p. 455
Pustula tragopogonis (Pers.) Thines, p. 455
Pythiopsis irregularis Seymour, p. 2
Pythiopsis papilliformis Seymour, p. 5
Ramularia pistiae R.C. Fernandes & R.W. Barreto, p. 50
Saprolegnia itoana (Nagai) Seymour, p. 28
Saprolegnia truncata Seymour, p. 9
Stenella deightoniana U. Braun, p. 404
Stenella hymenocallidis U. Braun & Crous, p. 403
Stenella stipae (H.C. Greene) K. Schub. & U. Braun, p. 71
Urocystis koeleriae L. Guo, p. 269
Urocystis sinensis L. Guo, p. 270
Verticimonosporium verticale M. Wang, L.M. Zhang & X.Z. Liu, p. 198
Wilsoniana Thines, p. 455
Wilsoniana achyranthis (Henn.) Thines, p. 456
Wilsoniana bliti (Biv.) Thines, p. 456
Wilsoniana platensis (Speg.) Thines, p. 456
Wilsoniana portulacae (DC. ex Duby) Thines p. 456
Xanthoparmelia viriduloumbrina (Gyelnik) Lendemer, p. 442

Author Index—Volume 92

- Adawadkar, Bharati & Urmila Makhija. Some trans-septate species of the genera *Hemithecium* and *Platythecium* from India. 92: 387–394. 2005.
- Akgül, Hasan, see Ergül et al.
- Anagnost, Susan E., see Fernando et al.
- Aptroot, André, see Yazici et al.
- Arenal, F., see Villareal et al.
- Aslan, Ali, see Yazici et al.
- Babu, K. Sharath, see Sureshkumar et al.
- Barbosa, Maria Angélica Guimarães, see Silva et al.
- Barreto, R.W., see Fernandes & Barreto
- Barreto, Robert W., see Soares & Barreto
- Baseia, I.G. & F.D. Calonge. *Aseroë floriformis*, a new phalloid with a sunflower-shaped receptacle. 92: 169–172. 2005.
- Bath, Amanjeet K., Monica S. Torres, Gary J. Samuels & James F. White, Jr. Morphology and species identification of a *Hypocrella* species (genbank accession # U47832). Mycotaxon 92: 97–102. 2005.
- Bi, TingJu, see Zhang et al.
- Bonfante, Paola, see Vizzini & Bonfante
- Boom, P.P.G. van den & A. Vězda. *Gyalecta canariensis* sp. nov., a new lichen (Ascomycota) described from La Palma (Canary Islands). 92: 255–258. 2005.
- Braun, Uwe, & Pedro W. Crous. Additions and corrections to names published in *Cercospora* and *Passalora*. 92: 395–416. 2005.
- Bridge, P.D., M.S. Clark & D.A. Pearce. A new species of *Paecilomyces* isolated from the Antarctic springtail *Cryptopygus antarcticus*. 92: 213–222. 2005.
- Cai, Lei, see Zhu et al.
- Calonge, F.D., see Baseia & Calonge
- Câmara, Marcos P. S., see Silva et al.
- Catranis, Catharine M., see Fernando et al.
- Chu, Huali, see Han et al.
- Cifuentes, Joaquín, see Sierra & Cifuentes
- Clark, M.S., see Bridge et al.
- Crous, see Braun & Crous
- Cunha, Marcos, see Whiting et al.
- Cunnington, James H., see Fischer et al.
- Dai, Yu-Cheng & Zheng Wang. A new polypore on Ginkgo from China. [5 pp. 1 line; 1 nom nov. 92: 245–249. 2005.
- Deng, H., & Y.-J. Yao. Revision of three species of *Tricholoma* reported from China. 92: 77–84. 2005.
- Deng, JingShi, see Zhang et al.
- Dokmetzian, Diana A., María E. Ranalli & Beatriz O. Saidman. Isozyme analysis of twelve species of the genus *Ascobolus*. 92: 295–309. 2005.
- Doležalová, Ivana, see Lebeda et al.
- Douanla-Meli, Clovis & Ewald Langer. Notes on Discomycetes (*Helotiales*, *Pezizales*): New species and new records from Cameroon. 92: 223–237. 2005.
- Dülger, Basaran, see Ergül et al.
- Edwards, Jacqueline, see Fischer et al.

- Ergül, C. Cem, Basaran Dülger & Hasan Akgül. Myxomycetes of Mezit Stream Valley of Turkey. 92: 239–242. 2005.
- Esteve-Raventós, F., see Ortega & Esteve-Raventós
- Fernandes, R.C. & R.W. Barreto. *Ramularia pistiae* sp. nov. – a new leaf spot fungus on water lettuce (*Pistia stratiotes*) from Nicaragua. Mycotaxon 92: 49–53. 2005.
- Fernando, Analie A., Susan E. Anagnost, Shannon R. Morey, Shuang Zhou, Catharine M. Catranis & C.J.K. Wang. Noteworthy microfungi from air samples. 92: 323–338. 2005.
- Fischer, Michael, Jacqueline Edwards, James H. Cunnington & Ian G. Pascoe. Basidiomycetous pathogens on grapevine: a new species from Australia - *Fomitiporia australiensis*. 92: 85–96. 2005.
- Gams, Walter & Amy Y. Rossman. What is *Oospora oryzae*? 92: 339–340. 2005.
- Gjærum, Halvor B., Mary Namaganda & Kåre Arnstein Lye. New rust fungi (*Uredinales*) from Mt. Elgon, Uganda. 92: 251–254. 2005.
- Groposo, Claudia & Clarice Loguercio-Leite. Contribution to the lignocellulolytic fungi (Basidiomycetes) of the Atlantic Rain Forest in Southern Brazil. 92: 103–106. 2005.
- Gubler, W. Douglas, see Whiting et al.
- Guo, Lin. Two new species of *Urocystis* (*Urocystales*) from China. 92: 269–272. 2005.
- Guzmán-Dávalos, L., see Sánchez-Jácome & Guzmán-Dávalos
- Han, Yanfeng, Huali Chu & Zongqi Liang. Two new species of the genus *Paecilomyces* in China. 92: 311–316. 2005.
- Hawksworth, David L.(ed.). Book reviews and notices. 92: 469–496. 2005.
- Hiratsuka, Kazuyuki, see Liang et al.
- Holec, Jan. Taxonomy and nomenclature of *Gymnopilus bellulus* and *G. microsporus* (*Agaricales*, *Cortinariaceae*). 92: 361–369. 2005.
- Hong Zhu, Lei Cai, Kevin D. Hyde & Keqin Zhang. A new species of *Acrogenospora* from submerged Bamboo in Yunnan, China. 92: 383–386. 2005.
- Hyde, Kevin D., see Zhu et al.
- Illana, C., see Moreno et al.
- Iturriaga, Teresa. Book review: Neotropical Polypores. Part 1. Introduction, *Ganodermataceae* & *Hymenochaetaceae* [Ryvarden 2004]. 92: 486–487. 2005.
- Ji, Min, see Zhang & Ji
- Johnson Jr., T.W., R.L. Seymour & D.E. Padgett. Systematics of the *Saprolegniaceae*: New taxa. 92: 1–10. 2005.
- Johnson Jr., T.W., R.L. Seymour & D.E. Padgett. Systematics of the *Saprolegniaceae*: New combinations. 92: 11–32. 2005.
- Kakishima, Makoto, see Liang et al.
- Kumar, T. K. Arun & P. Manimohan. A new species of *Lentinus* from India. 92: 119–123. 2005.
- Kunwar, I.K., see Sureshkumar et al.
- Langer, Ewald, see Douanla-Meli & Langer
- Laursen, G.A., see Zhurbenko et al.
- Lebeda, Aleš, Barbora Mieslerová & Ivana Doležalová. *Erysiphe pachypodii* – a new species on *Pachypodium lamerei*. 92: 285–287. 2005.
- Lendemer, James C. *Xanthoparmelia viriduloumbrina*, a neglected species from eastern North America. 92: 441–442. 2005.
- Li, Yan, see Su et al.
- Liang, Ying-Mei, Cheng-Ming Tian, Kazuyuki Hiratsuka & Makoto Kakishima. A new species of *Pucciniastrum* on *Enkianthus campanulatus* from Japan. 92: 371–376. 2005.
- Liang, Zongqi, see Han et al.

- Liberato, J.R., P.M. Stephens & R. G. Shivas. *Oidium moluccanum* nov. sp. causing powdery mildew on *Aleurites moluccanus* in East Timor. 92: 377–381. 2005.
- Liu, Xing-Zhong, see Wang et al.
- Liu, XueFeng, see Zhang et al.
- Loguercio-Leite, Clarice, see Groposo & Loguercio-Leite
- Lye, Kåre Arnstein, see Gjørum et al.
- Makhija, Urmila, see Adawadkar & Makhija
- Manimohan, P., see Kumar & Manimohan
- Manoharachary, C., see Sureshkumar et al.
- McHugh, Roland. Moist chamber culture and field collections of Ecuador myxomycetes. 92: 107–118. 2005.
- Menezes, Maria, see Silva et al.
- Mieslerová, Barbora, see Lebeda et al.
- Mo, MingHe, see Su et al.
- Mo, MingHe, see Zhang et al.
- Moreno, Gabriel. Book review: *Amanitales, Russulales* [Urbonas 2001]. 92: 484–485. 2005.
- Moreno, G., H. Singer & C. Illana. *Physarum styriacum*, a synonym of *Physarum vernum*. 92: 463–467. 2005.
- Morey, Shannon R., see Fernando et al.
- Namaganda, Mary, see Gjørum et al.
- Nuytinck, Jorinde & Annemieke Verbeken. Morphology and taxonomy of the European species in *Lactarius* sect. *Deliciosi* (*Russulales*). 92: 125–168. 2005.
- Ortega, A. & F. Esteve-Raventós. Preliminary checklist of the basidiomycetes from mediterranean inland dune ecosystems of Seville (Spain). 92: 437–440. 2005.
- Overall, Andy S. Book review: *Cortinarius* in Sweden [Soop 2004]. 92: 485–486. 2005.
- Padgett, D.E., see Johnson et al.
- Pascoe, Ian G., see Fischer et al.
- Pearce, D.A., see Bridge et al.
- Piątek, Marcin. *Kochmania*, a new genus of smut fungi and new records of cypericolous species from Poland and Ukraine. 92: 33–42. 2005.
- Rajchenberg, Mario & Gerardo L. Robledo. *Aleurocystis gloeocystidiata* sp. nov. on *Polylepis australis* in Argentina. 92: 317–322. 2005.
- Ranalli, María E., see Dokmetzian et al.
- Robledo, Gerardo L., see Rajchenberg & Robledo
- Rossman, Amy Y. Book review: CBS Centenary [Crous et al. (eds.) 2004]. 92: 470–471. 2005.
- Rossman, Amy Y., see Gams & Rossman
- Rubio, V., see Villareal et al.
- Ryvarden, Leif. Book review: Instruction to Fungi of New Zealand [McKenzie (ed.) 2004]. 92: 471–472. 2005.
- Saidman, Beatriz O., see Dokmetzian et al.
- Samuels, Gary J., see Bath et al.
- Sánchez-Jácome, María del Refugio, & L. Guzmán-Dávalos. New records of Ascomycetes from Jalisco State, Mexico. 92: 177–191. 2005.
- Schubert, Konstanze. Taxonomic revision of the genus *Cladosporium* s. lat. 3. A revision of *Cladosporium* species described by J.J. Davis and H.C. Greene (WIS). 92: 55–76. 2005.
- Seymour, R. L., see Johnson et al.
- Sierra, Sigfrido & Joaquín Cifuentes. A new species of *Dacryopinax* from Mexico. 92: 243–250. 2005.

- Shi, Cheng-Kuei** see **Zhang & Shi**
- Shivas, R.G.**, see **Liberato et al.**
- Silva, Adriano Márcio Freire, Maria Angélica Guimarães Barbosa, Maria Menezes & Marcos P. S. Câmara.** *Parapyricularia brasiliensis*, a new dematiaceous hyphomycete on *Gmelina arborea* from Brazil. 92: 43–47. 2005.
- Singer, H.**, see **Moreno et al.**
- Soares, Dartanha J. & Robert W. Barreto.** *Pseudocercospora siparunae* – a new cercosporoid fungus from the Brazilian tropical forest. 92: 273–277. 2005.
- Spring, Otmar**, see **Thines & Spring**
- Stephens, P.M.**, see **Liberato et al.**
- Stoykov, Dimitar Y.** *Apiognomonina fakirovae* sp. nov. (*Diaporthales*) on *Quercus cerris* (*Fagaceae*). 92: 459–462. 2005.
- Su, Hongyan, Yan Li, MingHe Mo & Keqin Zhang.** *Monacrosporium multiseptatum*, a new predacious fungus from China. 92: 193–196. 2005.
- Sun, Guangyu, Rong Zhang, Wang Zhou & Mingqi Zhu.** *Exserohilum heteromorphum* sp. nov., a new helminthosporioid fungus from *Echinochloa* in China. 92: 173–176. 2005.
- Sureshkumar, G., K. Sharath Babu, I.K. Kunwar & C. Manoharachary.** Two new hyphomycetous fungal species from India. 92: 279–283. 2005.
- Thines, Marco & Otmar Spring.** A revision of *Albugo* (Chromista, Peronosporomycetes). 92: 443–458. 2005.
- Tian, Cheng-Ming**, see **Liang et al.**
- Torres, Monica S.**, see **Bath et al.**
- Troya, M.T. de**, see **Villareal et al.**
- Tulloss, Rodham E.** Book review: *Amaniteae: Amanita, Limacella & Torrendia* [Neville & Poumarat 2004]. 92: 474–484. 2005.
- Verbeken, Annemieke**, see **Nuytinck & Verbeken**
- Vězda, A.**, see **Boom & Vězda**
- Villarreal, M., V. Rubio, M.T. de Troya & F. Arenal.** A new *Ophiostoma* species isolated from *Pinus pinaster* in the Iberian Peninsula. Mycotaxon 92: 259–268. 2005.
- Vizzini, Alfredo & Paola Bonfante.** Book review: *Polyporaceae* s.l. [Bernicchia 2005]. 92: 487–491. 2005.
- Walker, D.A.**, see **Zhurbenko et al.**
- Wang, C.J.K.**, see **Fernando et al.**
- Wang, Mu, Li-Mei Zhang & Xing-Zhong Liu.** *Verticimonosporium verticale* sp. nov. from Jiangxi Province, China. 92: 197–200. 2005.
- Wang, Zheng**, see **Dai & Wang.**
- White Jr., James F.**, see **Bath et al.**
- Whiting, Elizabeth, Marcos Cunha & W. Douglas Gubler.** *Phaeoacremonium* species and *Phaeomoniella chlamydospora* distinguished through cultural characters and ribosomal DNA sequence analysis. 92: 351–360. 2005.
- Xu, Jun-Jie**, see **Zhang & Xu**
- Yao, Y.-J.**, see **Deng & Yao**
- Yazici, Kenan, Ali Aslan & André Aptroot.** New lichen records from Turkey. 92: 341–344. 2005.
- Zhang, Jing, MingHe Mo, JingShi Deng, XueFeng Liu, TingJu Bi & KeQin Zhang.** *Dactylella zhongdianensis* sp. nov, a new predacious antagonist of nematodes. 92: 289–294. 2005.
- Zhang, KeQin**, see **Su et al.**
- Zhang, Keqin**, see **Zhang et al.**

Zhang, Keqin, see Zhu et al.

Zhang, Li-Mei, see Wang et al.

Zhang, Rong, see Sun et al.

Zhang, Xiu-Guo & Cheng Kuei Shi. Taxonomic studies of *Corynespora* from China. 92: 417–423. 2005.

Zhang, Xiu-Guo & Jun-Jie Xu. Taxonomic studies of *Corynespora* from Guangxi, China. 92: 431–436. 2005.

Zhang, Xiu-Guo & Min Ji. Taxonomic studies of *Corynespora* from Yunnan, China. *Mycotaxon* 92: 425–429. 2005.

Zhou, Shuang, see Fernando et al.

Zhou, Wang, see Sun et al.

Zhu, Mingqi, see Sun et al.

Zhurbenko, M.P., G.A. Laursen & D.A. Walker. New and rare lichenicolous fungi and lichens from the North American Arctic. 92: 201–212. 2005.

Zyska, Bronislaw. Book review: Macrofungi of North Korea collected in 1982–1986 [Wojewoda 2004]. 92: 472–474. 2005.

MYCOTAXON ONLINE RESOURCES: WWW.MYCOTAXON.COM

Index to fungous and lichen taxa—*Mycotaxon* proudly provides full indices to all authors and taxa that appear in its pages. We continue to print complete indices to authors in each *Mycotaxon* volume. Until 2004 (*Mycotaxon* 1–88), we also printed complete lists of taxa. Because digital files are far more conveniently searched than separate appendices in each print journal, we now post *Mycotaxon* taxonomic indices only online. To read or print the *Index to fungous and lichen taxa* for **Volume 92**, download our posted PDF file by clicking first on INDICES (in the list at the top of any webpage under the *Mycotaxon* header) and then TAXON INDEX, VOL 92.

Cumulative indices—Readers can now swiftly and easily locate taxonomic and author names in the cumulative indices to authors and taxa from earlier *Mycotaxon* volumes. The **Volume 91** author index is now incorporated into the VOLUMES 61–FF CUMULATIVE INDEX. Volume 91 & 92 taxonomic entries will eventually be integrated into TAXON INDEX, VOLUMES 91–FF. Earlier cumulative taxonomic indices now available for downloading include TAXON INDEX, VOLUMES 61–70; TAXON INDEX, VOLUMES 71–80; and TAXON INDEX, VOLUMES 81–90.

Distributional checklists—*Mycotaxon* posts downloadable PDF files or URL links first published in *Mycotaxon* by authors who amend or update species identifications, nomenclatural revisions, and range & substrate extensions as new data become available. To find the checklist page, first click ONLINE RESOURCEC (under the MYCOTAXON header) and then REGIONAL CHECK LISTS. Users may also find checklist PDFs and URLs by clicking on links in the summary abstracts. (Abstracts are found following the PUBLICATIONS -> VOLUME LISTING -> VOLUME NUMBER -> TITLE pathway.)

Search—The **search!** engine option in the top right corner of every *Mycotaxon* webpage is yet another way to search for authors, taxa, and other online resources. Currently it only indexes taxa cited in titles, abstracts, or keywords of published papers. The search button also finds all nomenclatural novelties.

Reviewers—Volume 92

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

Teuvo Ahti	Walter Gams	Lorelei L. Norvell
Vagn Alstrup	Irma J. Gamundi	N.R. O'Neill
Vladimír Antonín	Thomas Harrington	Yashitaka Ono
A. Aptroot	Tsutomu Hattori	Mary Palm
Alan W. Archer	Anton Hausknecht	David N. Pegler
Robert Bandoni	D.M. Henderson	Fernando Peláez
Vyrna Beilhärz	David S. Hibbett	Meike Piepenbring
Andre Bellemère	C.F. Hill	Martha J. Powell
D.J. Bhat	Kurt Hjörtstam	Chris Prior
Margaret Barr Bigelow	Klaus Høiland	Scott Redlin
Gerald Bills	Richard Humber	S.M. Reddy
Manfred Binder	Jichuan Kang	Peter Roberts
Uwe Braun	Maria Havrylenko	Leif Ryvarden
Irwin M. Brodo	W. Bryce Kendrick	Gary J. Samuels
Peter K. Buchanan	Paul M. Kirk	Martin Schnittler
Francisco D. Calonge	Richard P. Korf	Keith Seifert
Sharon Cantrell	Hanns Kreisel	Harrie Sipman
Santiago Chacón	ShiDong Li	Halvor Solheim
Shengjun Chang	XingZhong Liu	Elwin Stewart
Julia Checa	XueFeng Liu	Kálmán Vánky
Jianchi Chen	Pavel Lizon	Larissa Vasilyeva
Mariette S. Cole	Eric H.C. McKenzie	Ferenc Viranyi
Ovidiu Constantinescu	Marianne Meyer	Ruben Walley
Randolph Currah	David W. Mitchell	Jorge E. Wright†
Cony Decock	Gabriel Moreno	Diana Wrigley de Basanta
Frank Dugan	Gregory M. Mueller	Wenping Wu
R.S. Egan	R.K. Mukerji	Yi-Jian Yao
John A. Elix	Wieslaw Mulenko	Georgios I. Zervakis
Carol A. Ellison	T.H. Nash III	Tainyu Zhang
Theodore L. Esslinger	Tuomo Niemelä	Jian-Yen Zhuang
Fernando Fernandez	Machiel E. Noordeloos	Wenying Zhuang

Errata

Volume 91

Cover 1 & p. iii (p.1 title)	<i>for:</i> species to	<i>read:</i> species of
Cover 1 & p. iii (p. 133 title)	<i>for:</i> lichenisé	<i>read:</i> lichénisé
Cover 1 & p. iii (p. 172 title)	<i>for:</i> Newand	<i>read:</i> New and
Cover 2 & p. iv (p. 315 author)	<i>for:</i> Chavarria	<i>read:</i> Chavarría
Cover 2 & p. iv (p. 347 title)	<i>for:</i> islands	<i>read:</i> Islands
Cover 2 & p. iv (p. 369 title)	<i>for:</i> (lichenized	<i>read:</i> (Lichenized
p. iv, 4 th line from bottom	<i>for:</i> Peronosporomycetes)with	<i>read:</i> Perononosporomycetes) with
p. v, 8 th line from bottom	<i>for:</i> Heleococcum alkalinum	<i>read:</i> <i>Heleococcum alkalinum</i>
p. 344, line 6	<i>for:</i> Sarregui	<i>read:</i> Sarriegui
p. 353, Checa address, line 3	<i>before:</i> Madrid, Spain	<i>add:</i> 28871 Alcalá de Henares,
p. 411, 4 th line from bottom	<i>for:</i> Svrcek	<i>read:</i> Svřček
p. 411, 2 ND line from bottom	<i>for:</i> Velenovsk [✓]	<i>read:</i> Velenovský
p. 419, title	<i>for:</i> <i>Ascomycota</i>	<i>read:</i> Ascomycota
p. 475, line 17	<i>for:</i> describe basidiospores	<i>read:</i> describe constricted basidiospores
p. 477, line 5	<i>for:</i> ... 29BC6 29DE8-F5 29F7-8 30F8) <i>read:</i> ... 29BC6, 29DE8-F5, 29F7-8 30F8)	
p. 528, 2 nd line from bottom	<i>for:</i> 2500.	<i>read:</i> 2005.
p. 531. line 3	<i>for:</i> Piątek	<i>read:</i> Piątek
p. 531, line 15	<i>for:</i> lichenisé l	<i>read:</i> lichénisé—
Cover 3, 8 th line from bottom	<i>for:</i> Heleococcum alkalinum	<i>read:</i> <i>Heleococcum alkalinum</i>

MYCOTAXON is published quarterly during the periods of January–March, April–June, July–September, and October–December by Mycotaxon, Ltd., 316 Richard Pl., Ithaca, NY 14850–0264. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2005: In U.S. and possessions, one year, \$330; reduced rate for personal subscribers, one year, \$150. Foreign subscriptions, add \$40 for IMEX air mail.

POSTMASTER: Send address changes to Mycotaxon, Ltd., P.O. Box 264, Ithaca, NY 14851-0264.

[Content continued from inside front cover]

<i>Phaeoacremonium</i> species and <i>Phaeomoniella chlamydospora</i> distinguished through cultural characters and rDNA sequence analysis	Elizabeth Whiting, Marcos Cunha & W. Douglas Gubler	351
Taxonomy and nomenclature of <i>Gymnopilus bellulus</i> and <i>G. microsporus</i> (<i>Agaricales, Cortinariaceae</i>)	Jan Holec	361
A new species of <i>Pucciniastrum</i> on <i>Enkianthus campanulatus</i> from Japan	Ying-Mei Liang, Cheng-Ming Tian, Kazuyuki Hiratsuka & Makoto Kakishima	371
<i>Oidium moluccanum</i> nov. sp. causing powdery mildew on <i>Aleurites moluccanus</i> in East Timor	J.R. Liberato, P.M. Stephens & R. G. Shivas	377
A new species of <i>Acrogenospora</i> from submerged Bamboo in Yunnan, China	Hong Zhu, Lei Cai, Kevin D. Hyde & Keqin Zhang	383
Some trans-septate species of the genera <i>Hemithecium</i> and <i>Platythecium</i> from India	Bharati Adawadkar & Urmila Makhija	387
Additions and corrections to names published in <i>Cercospora</i> and <i>Passalora</i>	Uwe Braun & Pedro W. Crous	395
Taxonomic studies of <i>Corynespora</i> from China	Xiu-Guo Zhang & Cheng-Kuei Shi	417
Taxonomic studies of <i>Corynespora</i> from Yunnan	Xiu-Guo Zhang & Min Ji	425
Taxonomic studies of <i>Corynespora</i> from Guangxi, China	Xiu-Guo Zhang & Jun-Jie Xu	431
Preliminary checklist of the basidiomycetes from mediterranean inland dune ecosystems of Seville (Spain)	A. Ortega & F. Esteve-Raventós	437
<i>Xanthoparmelia viriduloumbrina</i> , a neglected species from eastern North America	James C. Lendemer	441
A revision of <i>Albugo</i> (Chromista, Peronosporomycetes)	Marco Thines & Otmar Spring	443
<i>Apiognomonina fakirovae</i> sp. nov. (<i>Diaporthales</i>) on <i>Quercus cerris</i> (<i>Fagaceae</i>)	Dimitar Y. Stoykov	459
<i>Physarum styriacum</i> , a synonym of <i>Physarum verum</i>	G. Moreno, H. Singer & C. Illana	463
Book reviews and notices	David L. Hawksworth	469
Nomenclatural novelties proposed in volume 92		497
Author index for volume 92		500
MYCOTAXON online resources (Index to Fungous and Lichen Taxa, cumulative indices, distributional checklists, search features)		504
Reviewers for volume 92		505
Errata for volume 91		506

EDITORS OF MYCOTAXON

Lorelei L. Norvell
EDITOR-IN-CHIEF

Pacific Northwest Mycology Service
6720 NW Skyline Boulevard
Portland, OR 97229, U.S.A.

David L. Hawksworth
BOOK REVIEW EDITOR
MycNova, Calle Aguila 12
Colonia La Maliciosa, Mataelpino
ES-28411 Madrid, Spain

Karen D. Gettelman
INDEX EDITOR
510 Lake Blvd., Apt. 166
Davis, CA 95616
U.S.A.

Grégoire L. Hennebert
FRENCH LANGUAGE EDITOR
32 Rue de l'Élevage
B-1340 Ottignies - LLN
Belgium

MYCOTAXON is a quarterly peer-reviewed journal devoted to mycological taxonomy and nomenclature. All articles are reviewed by specialists prior to submission. Publication is open to everyone. Papers may be in English or in French. Summaries in those or any additional languages desired by the authors are given for longer articles. Printing is on high quality, acid-free book paper. Authors prepare their own *text-ready* copy after having received critical comments from pre-submission reviewers. *Instructions to Authors* appeared in Mycotaxon 90: 495–507, 2004, updated on our website at <www.mycotaxon.com>. *Guidelines for Reviewers* appeared in Mycotaxon 78: 539–540, 2001, also updated on our website at <www.mycotaxon.com>.

SUBSCRIPTION INFORMATION

Current volumes contain at least 512 pages. All subscriptions are on an annual basis, with four quarterly issues each year. Personal subscriptions are available at a substantially reduced rate for individuals who agree not to deposit their copies in a library other than their personal one within 3 years of receipt. Do not address any orders to the Editors, but instead to the Mycotaxon Order Department, P.O. Box 264, Ithaca, NY 14851-0264 USA, or your agent. Prices and availability of back volumes will be sent upon request to that Department, but are also posted on-line at <www.mycotaxon.com>, or can be provided in an E-mail version on request to <info@mycotaxon.com>. Mycotaxon may also be obtained on a journal-exchange basis. Proposals for such exchanges from journals, institutions, or individuals with difficulty in obtaining foreign currency should be addressed to the Order Department.

The annual subscription rates for 2005 (four volumes) are

	USA	Foreign (IMEX air assist)
REGULAR (multi-user)	\$330	\$370
PERSONAL (individual)	\$150	\$190

All back volumes [except volumes 22, 24, 34(2), 35, 41, and 54, currently out of print] are available at \$35 each by surface mail, \$55 each by air mail. Volumes 1, 38, 39, 43 and 46 were reprinted in 2001; the original printing of volume 1, part 1 is provided, with parts 2 and 3 reprinted.

CUMULATIVE INDICES

Printed versions of the *Mycotaxon Cumulative Indices* for Volumes 1–20 (ISBN 0-930845-00-5), Volumes 21–40 (ISBN 0-930845-01-03), and Volumes 41–60 (ISBN 0-930845-07-02) are available (see descriptions at <www.mycotaxon.com> and order there or through your local bookstore's listings under "Books in Print"). An online *Cumulative Index to Taxa in Volumes 61–ff.* and the *Cumulative Author Index to Volumes 61–ff.* are posted at <www.mycotaxon.com>.

AVAILABILITY IN MICROFILM, PHOTOCOPY, & ELECTRONIC VERSIONS

MYCOTAXON is also available in *microfilm* from Bell & Howell Information and Learning, P. O. Box 1346, Ann Arbor, MI 48106-1346, U.S.A., through their Microfilm Catalog <www.lib.umi.com/sim>. *Tear sheets* or *photocopies* of individual articles may be obtained from ISI Document Solution through their website, <www.isidoc.com>, with payment only by credit card.

CONTACTING MYCOTAXON'S EDITOR-IN-CHIEF BY E-MAIL OR FAX

To reach the Editor-in-Chief regarding manuscripts, you may E-mail to <editor@mycotaxon.com> or you may Fax to Lorelei L. Norvell at +503.297.3296.

CONTACTING MYCOTAXON'S ORDER DEPARTMENT BY E-MAIL OR FAX

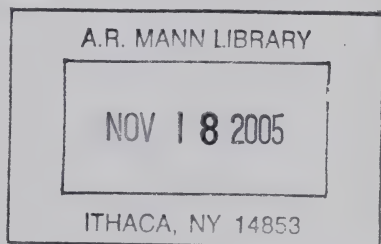
To reach the Order Department for information or placing orders, you may E-mail to <info@mycotaxon.com> or you may Fax to Orders, Mycotaxon, Ltd., May–October at +607.273.4357, and November–April at +727.321.1460.

VISIT MYCOTAXON ON THE WORLD WIDE WEB AT <www.mycotaxon.com>

<i>Ascocoryne striata</i> , comb. nov.	Viktor Kučera & Pavel Lizoň	163
<i>Inocutis subdryophila</i> (Basidiomycota), a new polypore from China	Yu-Cheng Dai & Hai-Sheng Yuan	167
Two new species of <i>Steccherinum</i> (Basidiomycota) from China	Hai-Sheng Yuan & Yu-Cheng Dai	173
New records and a new species of <i>Canalisporium</i> from aquatic habitats in Panama	Astrid Ferrer & Carol A. Shearer	179
<i>Amanita</i> —distribution in the Americas, with comparison to eastern and southern Asia and notes on spore character variation with latitude and ecology	Rodham E. Tulloss	189
<i>Penicillium brevistipitatum</i> , a new species isolated from Jilin Province, China	Long Wang & Wen-Ying Zhuang	233
NATS truffle and truffle-like fungi 11. <i>Hymenogaster raphanodorus</i> sp. nov. (Cortinariaceae)	Matthew E. Smith, James M. Trappe & David M. Rizzo	241
Genetic similarity and taxonomic relationships within the genus <i>Pleurotus</i> (higher Basidiomycetes) determined by RAPD analysis	Mirjana Stajić, Johannes Sikorski, Solomon P. Wasser & Eviator Nevo	247
Type studies on <i>Albatrellus henanensis</i> and <i>A. jianfenglingensis</i>	Huan-Di Zheng & Pei-Gui Liu	257
<i>Leptosphaeria raphani</i> – a new species on <i>Draba aspera</i> in Serbia	Jelena Vukojević, Milica Ljaljević Grbić, Branka Stevanović & Vladimir Stevanović	265
Myxomycetes of the Western Black Sea Region of Turkey	C. Cem Ergül, Başaran Dülger, R. Batur Oran & Hasan Akgül	269
A new <i>Lepraria</i> species from Gough Island, South Atlantic Ocean	John A. Elix, Dag Olav Øvstedal & Niek J.M. Gremmen	273
Changes and additions to the checklist of North American Lichens. - III	Kerry Knudsen & James C. Lendemer	277
Taxonomic studies of <i>Alternaria</i> 9: two new species and two new records from China	Xia Sun, Meng Zhang & Tian-Yu Zhang	283
Changes and additions to the North American lichen flora. - IV.	Kerry Knudsen & James C. Lendemer	289
A new species and its phylogenetic placement in the <i>Didymella/Phoma</i> complex (<i>Phaeosphaeriaceae</i> , <i>Pleosporales</i>)	Monica S. Torres, James F. White, Jr., Guadalupe Cazares, Marshall Bergen, Joseph F. Bischoff & Raymond F. Sullivan	297
<i>Hypoderma qinlingense</i> sp. nov. on <i>Sabina squamata</i> from China	Ying-Mei Liang, Cheng-Ming Tian, Zhi-Min Cao, Jun-Xiu Yang & Makoto Kakishima	309
<i>Melanogaster utriculatus</i> sp. nov. from Japan	Yun Wang, Michael A. Castellano & James M. Trappe	315
A study of wood decaying macrofungi of western Black Sea Region, Turkey	Ahmet Afyon, Muhsin Konuk, Dursun Yağiz & Stephan Helfer	319
The species of <i>Entyloma</i> (Ustilaginomycetes) on <i>Convolvulaceae</i>	Marcin Piątek	323
Three new rust species (<i>Uredinales</i>) from Turkey	Zeliha Bahçecioglu, Sanlı Kabaktepe & Bayram Yıldız	331
<i>Plenodomus morganjonesii</i> sp. nov. and a discussion of the genus <i>Plenodomus</i>	Monica S. Torres, Marshall Bergen, Shruti Singh, Joseph Bischoff, Raymond F. Sullivan & James F. White, Jr.	333

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE



Volume 93, 2005

COMPLETE IN ONE VOLUME

CONSISTING OF vi + 426 PAGES INCLUDING FIGURES

EDITOR-IN-CHIEF**LORELEI L. NORVELL**

editor@mycotaxon.com

Pacific Northwest Mycology Service

6720 NW Skyline Boulevard

Portland, Oregon 97229-1309 USA

ASSOCIATE EDITORS**NOMENCLATURE EDITOR****SHAUN R. PENNYCOOK**

PennycookS@LandcareResearch.co.nz

Manaaki Whenua Landcare Research

Auckland, New Zealand

BOOK REVIEW EDITOR**DAVID L. HAWKSWORTH**

MycNova, Calle Aguila 12

Colonia La Maliciosa, Mataelpino

ES-28411 Madrid, Spain

FRENCH LANGUAGE EDITOR**GRÉGOIRE HENNEBERT**

32 Rue de l'Élevage

B-1340 Ottignies – LLN, Belgium

INDEX EDITOR**KAREN D. GETTELMAN**

510 Lake Blvd., Apt. 166

Davis, CA 95616 U.S.A.

EDITORIAL ADVISORY BOARD

GARY J. SAMUELS, Beltsville, Maryland, USA (1997-2006), Chair

SEPPO HUHTINEN, Turku, Finland (2000-2005), Past Chair

DONALD H. PFISTER, Cambridge, Massachusetts, USA (1997-2007)

WEN-YING ZHUANG, Beijing, China (2003-2008)

CAROL A. SHEARER, Urbana, Illinois, USA (1998-2009)

SEAN ROSS PENNYCOOK, Auckland, New Zealand (2005-2010)

Published by

MYCOTAXON, LTD, PO BOX 264

Ithaca, NY 14851-0264, USA

www.mycotaxon.com

Printed in the United States of America

© Mycotaxon, Ltd, 2005

MYCOTAXON

VOLUME NINETY-THREE—TABLE OF CONTENTS

The taxonomy of <i>Echinochaete</i> and <i>Polyporus</i> s. str. in southern South America	Rosa Mara Borges da Silveira & Jorge Eduardo Wright	1
Type studies of some <i>Ganoderma</i> species from China	D.-M. Wang, X.-Q. Zhang & Y.-J. Yao	61
<i>Parmeliaceae</i> (Ascomycota) lichens in China's mainland. IV. <i>Melanelia</i> species new to China	Jian-Bin Chen & Theodore L. Esslinger	71
Myxomycetes from Chihuahua, Mexico III	M. Lizárraga, G. Moreno, C. Illana & H. Singer	75
A new species of <i>Morchella</i> (Pezizales, Ascomycota) from southwestern China	Ji-Yue Chen & Pei-Gui Liu	89
A new species of <i>Psilocybe</i> (Agaricales, <i>Strophariaceae</i>) from southern Brazil	Gastón Guzmán & Wagner Gularte Cortez	95
Some new species and new records of discomycetes in China. XII.	Wen-Ying Zhuang	99
On three foliicolous <i>Hyaloscyphaceae</i> on <i>Dryas</i>	Andrzej Chlebicki & Markéta Suková	105
<i>Cercospora agavicola</i> – a new foliar pathogen of <i>Agave tequilana</i> var. <i>azul</i> from Mexico	Victoria Ayala-Escobar, María de Jesús Yañez-Morales, Uwe Braun, Johannes Z. Groenewald & Pedro W. Crous	115
<i>Albatrellus ginnsii</i> sp. nov.	A.B. De	123
A new combination in <i>Lacrymaria</i> (Agaricales)	Wagner Gularte Cortez & Gilberto Coelho	129
A new species of <i>Vizella</i> from Australia	James Cunningham	135
<i>Sulcatistroma nolinae</i> (Calosphaeriales), and its <i>Phialophora</i> -like anamorph	Annette W. Ramaley	139
<i>Oidium stachytarphetae</i> on <i>Stachytarpheta</i> , emended: new from Australia and New Caledonia	J.R. Liberato, I.G. Pascoe, S.D. Campbell, J.G. Wright & R.G. Shivas	145
Two <i>Microbotryum</i> species from the Himalayas	Andrzej Chlebicki & Markéta Suková	149
<i>Tuber furfuraceum</i> sp. nov. from Taiwan	Hung-Tao Hu & Yun Wang	155
A new species and a new record of <i>Anthracoidea</i> (Ustilaginales) from China	Lin Guo & Shengrong Wang	159
<i>Ascocoryne striata</i> , comb. nov.	Viktor Kučera & Pavel Lizoň	163
<i>Inocutis subdriophila</i> (Basidiomycota), a new polypore from China	Yu-Cheng Dai & Hai-Sheng Yuan	167
Two new species of <i>Steccherinum</i> (Basidiomycota) from China	Hai-Sheng Yuan & Yu-Cheng Dai	173
New records and a new species of <i>Canalisporium</i> from aquatic habitats in Panama	Astrid Ferrer & Carol A. Shearer	179

PUBLICATION DATE FOR VOLUME NINETY-TWO
MYCOTAXON *for* APRIL-JUNE, VOLUME 92 (I-VI + 1-506)
was issued on July, 14, 2005

The taxonomy of *Echinochaete* and *Polyporus s. str.* in southern South America¹

ROSA MARA BORGES DA SILVEIRA

rosa.silveira@ufrgs.br

*Departamento de Botânica, Instituto de Biociências
Universidade Federal do Rio Grande do Sul
91501-970 Porto Alegre, RS, Brazil*

JORGE EDUARDO WRIGHT [†]

*Departamento de Ciencias Biológicas
Facultad de Ciencias Exactas y Naturales
Univerasidad de Buenos Aires
1428 Buenos Aires, Argentina*

Abstract—Taxonomic characters of the genera *Echinochaete* and *Polyporus s. str.* from southern South America are summarized based on examination of 350 collections, including 88 holotypes from different herbaria. The research revealed one species of *Echinochaete* and nineteen species and one variety of *Polyporus s. str.* representing four established subgenera (*Polyporus*, *Melanopus*, *Polyporellus*, *Favolus*), and the new subgenus, *Austropolyporus*, proposed here to accommodate *P. gayanus*. *Pseudofavolus* is considered a synonym of *Polyporus s. str.* *Polyporus arcularioides* is accepted as a separate taxon. *Polyporus brumalis* was not found in the area studied. *Polyporus saltensis*, considered an autonomous taxon, differs from *P. tenuiculus* in lacking clamp connections. *Polyporus tucumanensis* is recognized as a separate species distinct from *P. ciliatus*. *Polyporus maculatissimus*, usually considered within *Polyporus s. str.*, belongs in *Neolentiporus*.

Key words—Basidiomycota, *Polyporaceae*, morphology

Introduction

Polyporus s. str. and related genera have been given scant attention in South America. A study was thus undertaken, involving not only the taxonomy of the species, but also mating (Silveira & Wright 2002) and isoenzymatic studies (Silveira et al. 2003) in order to establish relationships among the species.

¹This paper is part of the first author's thesis in partial fulfillment of the requirements for her Ph.D. from the University of Buenos Aires, Argentina. This research was supported by CAPES – Brasília/Brazil and PRHIDEB-CONICET/ Argentina.

[†]Dr. Jorge Eduardo Wright, deceased, January 4, 2005.

As emended by Donk (1960) and accepted by most later authors (Kreisel 1960; Jahn 1969; Bernicchia 1990; Niemelä & Kotiranta 1991; Ryvarden & Gilbertson 1994; Núñez & Ryvarden 1995b), *Polyporus* constitutes a fairly homogeneous genus diagnosed by a well developed to reduced stipe, growth directly on wood or from a sclerotium, a dimitic hyphal system with skeleto-binding hyphae (Corner 1984), hyaline, smooth, cylindric to subellipsoid, IKI- basidiospores, producing a white rot, and heterothallic and tetrapolar mating types.

Most authors currently accept *P. tuberaster* (Jacq.: Fr.) Fr. as the holotype of the genus (cf. Ryvarden 1991).

Polyporellus P. Karst., which was included the stipitate species growing on wood with a coriaceous to suberous pileus, was later divided by Quélet (1886) into *Cerioporus* Quélet and *Leucoporus* Quélet. Patouillard (1887) created *Melanopus* for species with a black stipe. All those genera are currently regarded as synonyms of *Polyporus* (Murrill 1904; Donk 1960; Ryvarden 1991, Núñez & Ryvarden 1995b).

Singer (1986) cited the following synonyms for *Polyporus*: *Favolus* Fr.: Fr., *Polyporellus* P. Karst., *Bresadolia* Speg., *Leucoporus* Quélet., *Melanopus* Pat., *Asterochaete* (Pat.) Bondartsev & Singer, *Echinochaete* D.A. Reid, and *Hexagonia* Pollini.

Several subgenera are currently accepted, such as: *Favolus*, *Melanopus*, *Polyporellus*, and *Polyporus* (Singer, 1986; Gibertoni et al., 2004; Ryvarden & Iturriaga, 2004).

Núñez & Ryvarden (1995b) published a worldwide manual on *Polyporus* based on morphological traits. The goal of the current research was to present a morphological study of *Polyporus* s. str. taxa in southern South America. We propose to add to or modify Núñez & Ryvarden's concepts.

Materials and Methods

Area of study — The area is currently known as the South Cone of America, which is usually understood as the triangular mass land south of the Tropic of Capricorn, but for practical reasons we have considered the parallel 20° S as the northernmost boundary. From the phytogeographic viewpoint it includes several regions (Cabrera & Willink 1980).

Materials studied — This study is based mostly on collections kept at BAFC, CTES and ICN. Holotypes are mainly from LPS, K, UPS, and PC. Abbreviations are those of Holmgren & Holmgren (1992). Colours are based on Munsell (1954). Several field trips were undertaken with the aim of obtaining more samples.

Trips were made to: a) Barra do Ribeiro, Rio Grande do Sul, Brazil; b) Canela, Rio Grande do Sul, Brazil; c) Chichigasta, Tucumán, Argentina; d) Curitiba, Paraná, Brazil; e) Florianópolis, Santa Catarina, Brazil; f) La Plata, Buenos Aires, Argentina; g) Monteros, Tucumán, Argentina; h) Nova Petrópolis, Rio Grande do Sul, Brazil; i) Iguazú Nat'l Park, Misiones, Argentina; j) Lago Puelo Nat'l Park, Chubut, Argentina; k) Los Alerces Nat'l Park, Chubut, Argentina; l) St. Hilaire Park, Viamão, Rio Grande do Sul, Brazil; m) Porto Alegre, Rio Grande do Sul, Brazil; n) Santa Catalina, Buenos Aires, Argentina. Map on Fig. 1 shows the areas where materials were collected.



Figure 1: Map of southern South America showing the areas where materials were collected. — Barra do Ribeiro, Porto Alegre and St. Hilaire Park (Viamão) - RS, Brazil; □ Canela and Nova Petrópolis - RS, Brazil; u Chiclegasta and Monteros – Tucumán, Argentina; l Curitiba - PR, Brazil; n Florianópolis - SC, Brazil; x La Plata and Santa Catalina- Buenos Aires, Argentina; v Iguazú Nat'l Park – Misiones, Argentina; μ Lago Puelo Nat'l Park and Los Alerces Nat'l Park – Chubut, Argentina.

Microscopic examination of basidiocarps was made from freehand sections mounted in a drop of 5 % KOH solution and 1% aqueous phloxine solution; amyloid or dextrinoid reactions were observed in Melzer's reagent. Measurements were obtained from at least 20 spores. For each species, representative basidiomes were chosen and photographed. Microscopic structures were observed and drawn with the aid of a Wild camera lucida

Delimitation of some species is based on molecular biology (Silveira et al., 2003) and mating tests (Silveira & Wright, 2002), which are added as possible techniques for studying populations.

Taxonomy

Key for the determination of genera and species studied

1. Stipe dark brown to black, sometimes only at the base 2
- 1'. Stipe concolorous with pileus surface, or absent 9
2. Pores large, 0.5-4 per mm 3
- 2'. Pores medium sized to small, 4-9 per mm 6
3. Surface of pileus brown to vinaceous brown, pores circular to angular, 1-4 per mm
..... **9. *P. guianensis* var. *guianensis***
- 3'. Surface of pileus cream coloured to yellowish brown or ashy beige, pores 0.5-4
per mm 4
4. Basidiomata small, 1.3-2.5 cm in diam., on roots of living grasses
..... **14. *P. rhizophilus***
- 4'. Basidiomata up to 11.0 cm in diam., on dead wood of angiosperms 5
5. Basidiomata centrally stipitate, pores ellipsoid to angular, 0.5-1.5 per mm
..... **10. *P. guianensis* var. *puttemansii***
- 5'. Basidiomata laterally stipitate, pores circular to angular, 2-4 per mm.
..... **21. *P. virgatus***
6. Pileus surface cream coloured to light brown, smooth to finely striate radially.
..... **20. *P. varius***
- 6'. Pileus surface brown to vinaceous brown or tobacco coloured 7
7. Pileus flabelliform, very thin, 0.5-1 mm thick, surface tobacco coloured
..... **11. *P. leprieurii***
- 7'. Pileus flabelliform to circular or infundibuliform, 1-4 mm thick, surface brown to
vinaceous brown 8
8. Pores 3-7 per mm, in temperate-cold zones, on *Nothofagus* wood
..... **12. *P. melanopus***
- 8'. Pores 6-9 per mm, in subtropical-tropical zones, on wood of several angiosperms
..... **7. *P. dictyopus***
9. Basidiomata coriaceous, stipe central to eccentric stipitate 10
- 9'. Basidiomata fleshy to coriaceous, stipe lateral or excentric or absent 14
10. Pores hexagonal, radially elongated, 1-3 per mm 11
- 10'. Pores circular to angular, 3-9 per mm 12
11. Pileus surface with triangular scales, marginal cilia squamiform. . **3. *P. arcularius***
- 11'. Pileus surface without scales, margin entire or lobulate **2. *P. arcularioides***
12. Pores angular, medium sized, 3-5 per mm **18. *P. tucumanensis***
- 12'. Pores circular, small, 5-9 per mm. 13

13. Basidiomata small, 0.7-2.5 cm in diam., solitary or cespitose, surface cream coloured to light brown, margin with filiform cilia. **17. *P. tricholoma***
- 13'. Basidiomata 2.0-7.0 cm in diam., solitary, surface brown to dark brown, margin ciliate or entire **4. *P. ciliatus***
14. Setoid elements present in the hymenium and tube mouths **1. *Echinochaete brachypora***
- 14'. Setoid elements lacking 15
15. Pores medium sized to small, 4-7 per mm, pileus sometimes infundibuliform. **6. *P. cyathiformis***
- 15'. Pores large, 0.5-4 per mm, pileus predominantly flabelliform 16
16. Stipe absent or reduced to a mucro, pileus flabelliform to conchoid, in *Nothofagus* woods. **8. *P. gayanus***
- 16'. Stipe present, sometimes reduced, pileus circular to flabelliform 17
17. Generative hyphae simple septate **15. *P. saltensis***
- 17'. Generative hyphae clamped 18
18. Spores very large, 13-17 x 5-7 μm **5. *P. curtipes***
- 18'. Spores smaller, 7-13 x 2.5-4.5 μm 19
19. Pileus surface brown to dark brown, context spongy and watery when fresh, corky upon drying **19. *P. udus***
- 19'. Pileus surface white to light brown, context cottony to corky 20
20. Pileus surface beige to light brown, pores 1-3 per mm **13. *P. philippinensis***
- 20'. Pileus surface white to cream colored, pores 0.6-1.5 per mm **16. *P. tenuiculus***

Descriptions of genera and species

ECHINOCHAETE D.A. Reid, Kew Bull. 17: 283. 1963.

Basidiocarp annual, flabelliform to spatulate, with a short mucro-like stipe. **Pileus** velutinous, especially near the base, glabrous when old, whitish to pinkish when fresh, reddish to brown when dry. **Pores** angular to hexagonal, small to large. **Hyphal system** dimitic; generative hyphae hyaline, thin-walled, clamped; skeleto-binding hyphae thick-walled, golden to ferrugineous. **Context** hyphae strongly dextrinoid; spiny setae-like elements present in the pileus surface, hymenium and tube walls. **Basidiospores** cylindric to ellipsoid, hyaline, smooth, thin-walled. On wood of deciduous trees causing a white rot.

Type species: *Polyporus megaloporus* Mont.

Remarks: the genus is characterized by the setoid elements on the pileus surface, hymenium and pores, and by the strongly dextrinoid context hyphae. We maintain the genus separate from *Polyporus* on this basis, criterion also used by different authors to separate genera in other polypores. It is also accepted by Núñez & Ryvarden (1995b).

Species separation is based mainly on measurements, particularly of the setoid elements.

1. *Echinochaete brachypora* (Mont.) Ryvarden, Bull. Jard. Bot. Nat. Belgique 48: 101. 1978, as '*brachysporus*'.

FIGURE 2 and PLATE 1A

= *Polyporus brachyporus* Mont., Ann. Sci. Nat., ser. 4, 1: 131. 1854.- *P. megaloporus* Mont., *ibid.*, p. 124. 1854 non *P. megaloporus* Pers. 1825.- *Favolus brunneolus* Berk. & M.A. Curtis, J. Linn. Soc. London X, part 1: 321. 1869.- *Favolus princeps* Berk. & M.A. Curtis, J. Linn. Soc. London X, part 1: 321. 1869.- *F. balansae* Speg., Rev. Mycol. 11(42): 94. 1889.

Basidiocarp annual, lateral to eccentrically stipitate; **pileus** flabelliform, sometimes lobulate, 20-75 x 20-55 mm in diam. and up to 2 mm thick, fragile, easily broken upon drying. **Pileus surface** glabrous, smooth, concentrically zonate, brown (5YR 4/4) to dark brown (5YR 3/3 to 10YR 3/2), when dry. **Margin** smooth, entire to slightly lobulate. **Stipe** cylindric, 4-18 mm long, and up to 8 mm in diam., rigid when dry, glabrous, concolorous with the hymenophore. **Hymenophore** brown (5YR 3/4) to dark brown (10YR 2/2). **Pores** circular to angular, 3-4 per mm (in the holotype), 1-2 per mm (in other collections), tubes up to 2 mm long. **Context** homogeneous, waxy, beige to dark brown, up 1 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 2.5-5.0 μ m in diam., abundant throughout the basidiome; skeleto-binding hyphae thick-walled, lumen visible, 4.5-12.0 μ m in diam., hyaline to golden, moderately to much branched, abundant throughout the basidiome. **Setae** with pointed or blunt protuberances, present in the hymenium and trama, thick-walled, yellow or light brown, 20-50 x 4-13 μ m. **Hymenium** formed by clavate basidia. **Basidiospores** cylindric, thin-walled, hyaline, 8.5-13.0 x 3-5 μ m.

Cultural features: unknown.

Substrate: dead undetermined dicot wood.

Distribution: NE Argentina, Cuba, French Guyana, Paraguay. Pantropical according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — **ARGENTINA.** MISIONES: Iguazú Nat'l Park, Falls, 5.III.1982, leg. J. E. Wright M3518 (BAFC 28297). **CUBA.** leg. C. Wright 317 (**HOLOTYPUS** of *Favolus princeps* K 77609): 327 (**HOLOTYPUS** of *F. brunneolus* K 77608). **FRENCH GUYANA.** leg. Leprieur 959 (**HOLOTYPUS** of *Polyporus brachyporus* PC); leg. Leprieur (**HOLOTYPUS** of *P. megaloporus* PC). **PARAGUAY.** Guarapi, 1884, leg. Balansa (**HOLOTYPUS** of *Favolus balansae* LPS 21253).

Remarks: Our collections agree with the descriptions of Reid (1963) and Núñez & Ryvarden (1995b).

POLYPORUS Fr.: Fr. Observ. Mycol. 1: 121. 1815

= *Hexagonia* Pollini, Hort. Veron. p. 35, 1818 (*H. mori* Pollini, nom. rejiciendum, see ICBN, Appendix IIIA).- *Favolus* Fr., Elench. Fung. 1: 44. 1828 (*Daedalea brasiliensis* Fr.).- *Polyporellus* P. Karst., Meded. Soc. Fauna Fl. Fenn. 5: 37. 1880 (*Boletus brumalis* Pers.).- *Bresadolia* Speg., An. Soc. Cient. Argent. 16: 277. 1883. (*B. paradoxa* Speg.).-

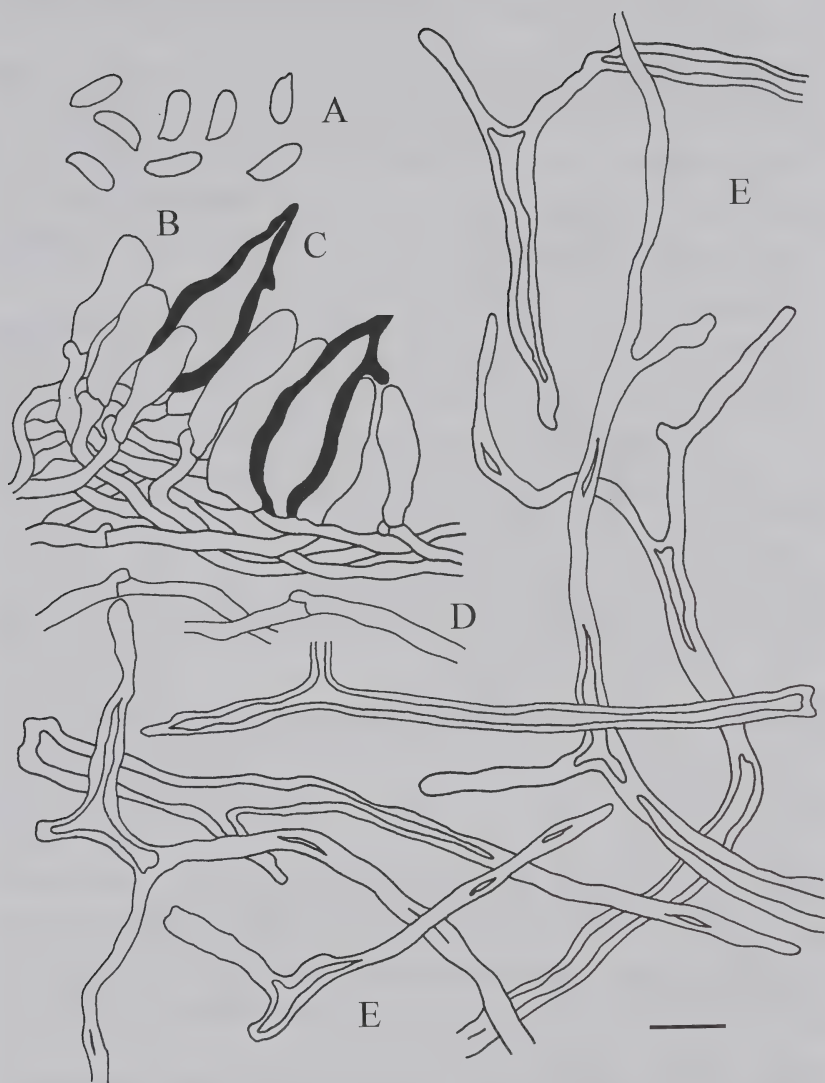


Figure 2: *Echinochaete brachyporus* (BAFC 28297). A) spores; B) basidioles; C) setoid elements; D) generative hyphae; E) skeleto-binding hyphae. Scale bar = 13 μ m.

Cerioporus Quél., Ench. Fung. P. 167. 1886 (*Boletus squamosus* Huds.).- *Cladomeris* Quél., Ench. Fung. P. 167. 1886 (*P. umbellatus* Fr.).- *Leucoporus* Quél., Ench. Fung., p. 165. 1886 (*P. ciliaris* Fr.).- *Melanopus* Pat., Hymen. Europ. p. 137. 1887 (*Boletus squamosus* Huds.).- *Pseudofavolus* Pat., Essai. Tax. Hymen. p. 80. 1900 (*P. miquelii* Mont.).- *Lentus* Torrend, Broteria (ser. Bot.) 18: 121. 1920 (*Boletus brumalis* Pers.).-

Atroporus Ryvarden, Norw. J. Bot. 20: 2. 1973 (*P. diabolicus* Berk.).- *Dendropolyporus* (Pouzar) Jülich, Bibliot. Mycol. 85: 397. 1981 (*P. umbellatus* Fr.).- *Royoporus* A.B. De, Mycotaxon 60: 143, 1996.

Basidiocarp annual or biannual, central to laterally stipitate or substipitate. **Pileus** circular to dimidiate, convex or infundibuliform, smooth to scaly, glabrous to finely tomentose, white, brown or black, coriaceous when fresh, rigid or fragile when dry. **Pore** surface white to cream coloured, or dark brown when dry; pores entire, circular to angular, small to large, decurrent or not on the stipe. **Context** white to light brown. **Stipe** cream coloured to black, glabrous to finely tomentose, with or without a cuticle, smooth or longitudinally wrinkled, in some species originating from a sclerotium, in others transformed from rhizomorphs.

Hyphal system dimitic; generative hyphae hyaline, mostly with clamps, some species with simple septa, brown on the pileus surface and stipe, thick-walled, forming a palisade or cutis; skeleto-binding hyphae hyaline to brown, solid or with visible lumen. **Cystidia** absent. **Hyphal pegs** present or absent. **Basidia** clavate, 4-spored. **Basidiospores** cylindric to subellipsoid, straight or slightly curved, thin-walled, smooth, hyaline, IKI-. On living or dead wood, rarely on conifers, or developing from a sclerotium buried in the ground or immersed in wood. Saprophytic, rarely parasitic, producing a white rot. Heterothallic and tetrapolar. Cosmopolitan genus.

Type species: *Polyporus tuberaster* (Jacq.: Fr.) Fr.

Remarks: *Echinochaete* is here circumscribed in the strict sense in which it is accepted today. It is characterized by the stipitate basidiome and the dimitic hyphal system with skeleto-binding hyphae.

Infra-generic scheme and disposition of southern South American taxa

Subgenus 1. *Polyporus*

Basidiocarps fleshy, more than 10 mm thick when fresh, pores medium sized, spores longer than 8 μm .

P. cyathiformis Lév., *P. udus* Jungh.

Subgenus 2. *Melanopus* Pat., Hyménomyc. Eur.: 137. 1887.

Basidiocarps coriaceous, up to 10 mm thick, with a melanized cortex, at least at the base of stipe.

P. dictyopus Mont., *P. guianensis* Mont., *P. guianensis* var. *puttemansii* (Henn.) R.M. Silveira & J.E. Wright, *P. leprieurii* Mont., *P. melanopus* (Pers.:Fr.) Fr., *P. rhizophilus* Pat., *P. varius* Fr.: Fr., *P. virgatus* Berk. & M.A. Curtis

Subgenus 3. *Polyporellus* P. Karst., Meddn. Soc. Fauna Flora Fenn. 5: 37. 1879.

Basidiocarps coriaceous, centrally to eccentrically stipitate, without a melanized cortex on the stipe.

P. arcularioides A. David & Rajchenb., *P. arcularius* (Batsch : Fr.) Fr., *P. ciliatus* Fr.: Fr., *P. tricholoma* Mont., *P. tucumanensis* Speg.

Subgenus 4. *Favolus* P. Beauv.: Fr., Elench. Fung. 1: 44. 1828.

Basidiocarps fleshy to membranous when fresh, laterally stipitate, flabelliform, up to 8 mm thick; pores large, up to 3 per mm; spores generally longer than 10 μm .

P. curtipes (Berk. & M.A. Curtis) Ryvarden, *P. philippinensis* Berk., *P. saltensis* (Speg.) R.M. Silveira & J.E. Wright, *P. tenuiculus* (P. Beauv.: Fr.) Fr.

Subgenus 5. *Austropolyporus* R.M. Silveira & J.E. Wright, **subgen. nov.**

Basidiocarpus tenax vel lignosus, stipes absens, dimidiatus vel conchatus, tantum in Nothofagetum. Typus hic designatus: P. gayanus Lév.

Basidiocarps resistant to woody, stipe absent or only a mucro, dimidiate to conchoid, only found in the *Nothofagus* area.

Remarks: Nuñez & Ryvarden (1995b) included *Polyporus gayanus* in the “*Admirabilis* group” together with *P. admirabilis* Peck and *P. pseudobetulinus* (Murashk. ex Pilát) Thorn, Kotir. & Niemelä – two species not present in the area under study. This group includes species with convex to flat, substipitate basidiocarps that are thicker than 8 mm. Because these authors did not propose a formal name for the group, we propose a new subgenus to accommodate *P. gayanus* based on its restricted distribution.

2. *Polyporus arcularioides* A. David & Rajchenb., Mycotaxon 22: 285. 1985.

FIGURE 3

Basidiocarp annual, central to eccentrically stipitate. Pileus circular, plane to infundibuliform, 15-40 mm in diam. and up to 3 mm thick, coriaceous when fresh, fragile and friable when dry. Pileus surface glabrous or downy, wrinkled when dry, brown (5YR 3/4) to ochraceous brown (7.5YR 5/6) or beige (10YR 7/4) when dry. Margin smooth, entire to lobulate, recurved when dry. Stipe cylindric or tapering towards the base, 15-35 mm long and up to 3 mm in diam., rigid when dry, glabrous, concolorous with the hymenophore. Hymenophore beige (10YR 7/4) to light brown (10YR 5/6). Pores hexagonal alveolate, radially elongated, 1-3 per mm, decurrent on the stipe, tubes up to 2.5 mm long, with the mouths fimbriate. Context homogeneous, cottony, beige, up to 0.5 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 2-5 μm in diam., sclerified in the stipe, arranged parallel to the main axis, skeleto-binding hyphae thick-walled, lumen visible, 3-5 μm in diam., hyaline to yellowish, moderately branched, dominating in the context. **Hymenium** formed by clavate, 4-spored basidia, 15-25 x 5-6 μm . **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 6-8(-9) x 2.5-3.5 μm .

Cultural features: unknown.

Susubstrate: dead wood of undetermined dicots.

Distribution: Argentina, Bolivia, S Brazil, Martinique and Paraguay.

SPECIMENS EXAMINED — **ARGENTINA.** MISIONES: Colonia Belgrano, II.1965, leg. C. E. Gómez (BAFC 50668); forest SE of Forestry Station, 29.X.1973, leg. Wright, Deschamps & Del Busto M2470 (BAFC 50669); Iguazú Nat'l Park, I.1980, leg. J. E. Wright (BAFC 50670). **BOLIVIA.** Pando, Sena, Río Madre de Dios, 15.X.1923, leg. J. R. Weir (BAFC 25194). **BRAZIL.** PARANÁ: Gral. Carneiro, Fazenda São Pedro,

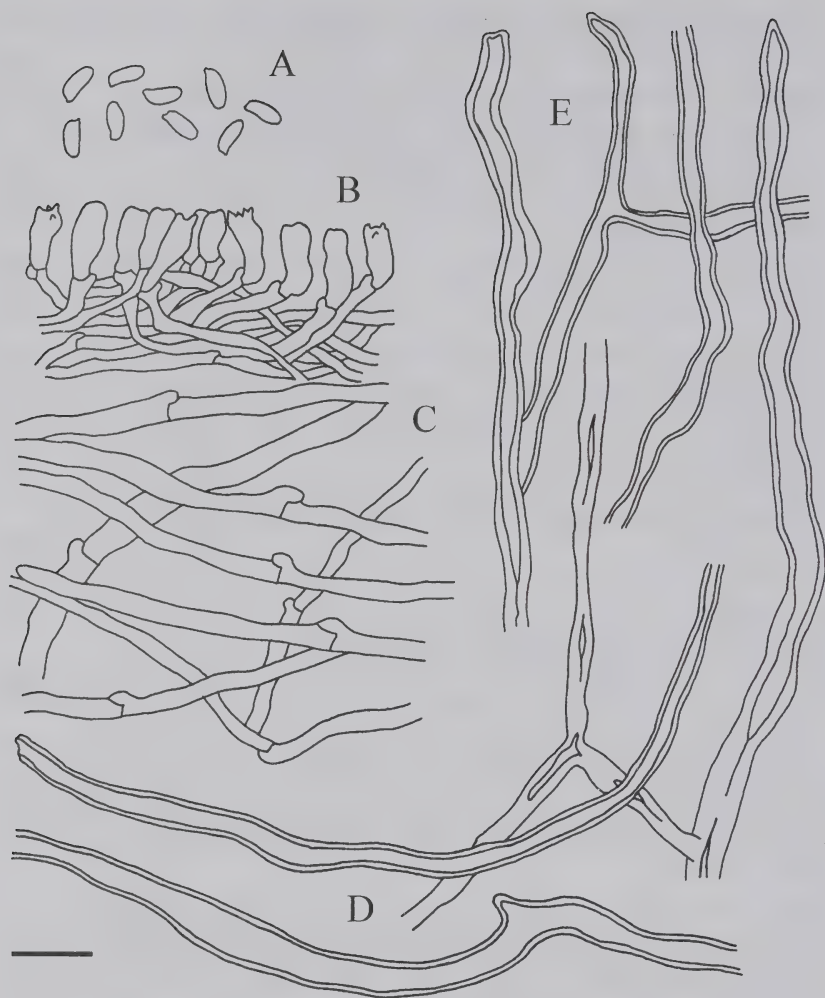


Figure 3: *Polyporus arcularioides* (BAFC 50669). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae (context); E) skeleto-binding hyphae (dissepiments). Scale bar = 13 μ m.

4.X.1989, leg. A. de Meijer 1380 (BAFC 50744); So PAULO: Itu, Fazenda So Miguel, 24.X.1987, leg. A. de Meijer 936 (BAFC 31305). MARTINIQUE. Prrcheur, 19.VII.1972, leg. A. David (**HOLOTYPE**, LY-AD 1323). PARAGUAY. Alto Paran, Reserva Itab, 9.X.1990, leg. O. Popoff *et al.* 846 (CTES).

Remarks: it is easy to mistake *Polyporus arcularioides* for *P. arcularius*, which is separated by the presence of pilear scales, of cilia on the margin and of hyphal pegs in the tubes. Furthermore, its pores are somewhat larger than in *P. arcularioides*.

3. *Polyporus arcularius* (Batsch: Fr.) Fr., Syst. Mycol. 1: 342. 1821.

FIGURE 4 and PLATE 1B

=*Boletus arcularius* Batsch, Elench. Fung. p. 97. 1783.- *Favolus ciliaris* Mont., Ann. Mag. Nat. Hist. Sci. Nat., sér. 2, 20: 364. 1843.- *Polyporus agariceus* Berk., Ann. Mag. Nat. Hist. 10: 371. 1843.- *P. nanus* Durieu & Mont., Syll. Gen. Spec. P. 153. 1856.- *Favolus curtisii* Berk., Grevillea 1: 68. 1872.- *F. squamiger* Berk., Grevillea 1: 166. 1872.

Basidiocarp annual, centrally stipitate. **Pileus** circular, umbilicate, 20-30 mm in diam., but may reach up to 60 mm and 3 mm thick, coriaceous when fresh, breakable upon drying. **Pileus** surface scaly, scales triangular, concentrically arranged on all the surface, light brown (10YR 6/6) to ochraceous brown (10YR 5/6). **Margin** provided with squamiform, triangular cilia. **Stipe** cylindric, somewhat broadened towards the base, 25-40 mm long and 2 mm in diam., fibrous, glabrous, concolorous with the pileus. **Hymenophore** beige (10YR 7/4) to light brown (10YR 6/6), or ochraceous (7.5YR 5/6). **Pores** hexagonal, alveolar, radially elongated, 1-2 per mm, decurrent on stem, tubes up to 3 mm long, with hyphal pegs on the walls. **Context** much reduced, ca. 0.2 mm thick, homogeneous, waxy, cream coloured.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin- to slightly thick-walled, 1.5-4 μ m in diam., sclerified in the stipe, arranged parallel to the principal axis and up to 7 μ m diam; skeletal-binding hyphae thick-walled to solid, 2-8 μ m in diam., up to 10 μ m diam. in the context, hyaline to yellowish, moderately branched, dominating in the dissepiments and context. **Hymenium** formed by clavate 4-spored basidia with a basal clamp, 14-20 x 4-5 μ m. **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 6-9 x 2-3 μ m.

[Cultural features: Wright (1948, as *Favolus squamiger*); Noble's (1948, 1958, 1965, 1971); Matters et al. (1952); Bakshi et al. (1969); Siepmann (1971); Nakasone & Gilbertson (1978), Stalpers (1978, as *P. alveolaris*).

Substrate: dead wood of several dicots like *Ailanthus*, *Eucalyptus*, *Ligustrum*, *Salix*, *Ulmus*. Also on dead wood of conifers of the genus *Pinus*.

Distribution: Argentina (Buenos Aires and Entre Ríos), Brazil, French Guyana, Paraguay, Trinidad and Uruguay. Cosmopolitan, according to Núñez & Ryvarden (1995b), excepting the boreal region.

SPECIMENS EXAMINED — **ALGERIA.** Mascara, leg. Durieu (**HOLOTYPE** of *Polyporus nanus* **PC**). **ARGENTINA.** **BUENOS AIRES:** Belén de Escobar, El Cazador, 14.II.1971, leg. G. Guzmán (BAFC 50648), in woods of *Pinus* and *Eucalyptus*; Paraná de las Palmas, 31-XII-1972, leg. Deschamps, Rovetta & Vicari (BAFC 50655), on branchlet of *Salix humboldtiana*; Delta of Paraná, 7.XII.1964, leg. Singer S457 (BAFC 50658); Derqui, 21.XI.1987, leg. D. Cabral (BAFC 31071); Ezeiza or Delta, XII.1967, leg. J. E. Wright (BAFC 50650); Ezeiza, 29.X.1967, leg. ibid (BAFC 50657); 11.XI.1969, leg. J. E. Wright & J. R. Deschamps (BAFC 50663); La Plata, La Balandra, 29.XI.1961, leg. J. R. Deschamps (BAFC 50651), on stump of *S. humboldtiana*; Punta Lara, 4.XI.1962, leg. L. Bettucci (BAFC 50660); 27.II.1973, leg. Ruiz (BAFC 50654); 28.XI.1997, leg. R. M. Silveira & E. Albertó 346 (BAFC 50673); Llavallol, Sta. Catalina, 15.VIII.1970, leg. J. R. Deschamps (BAFC 50666), on dead wood of *Ulmus* sp., 24-XII-1971, leg. J. R. Deschamps and G. Rovetta (BAFC 50659); 5.III-1972, leg. J. E. Wright (BAFC 50664, 59665); 20.XII. 1972, leg. Deschamps,

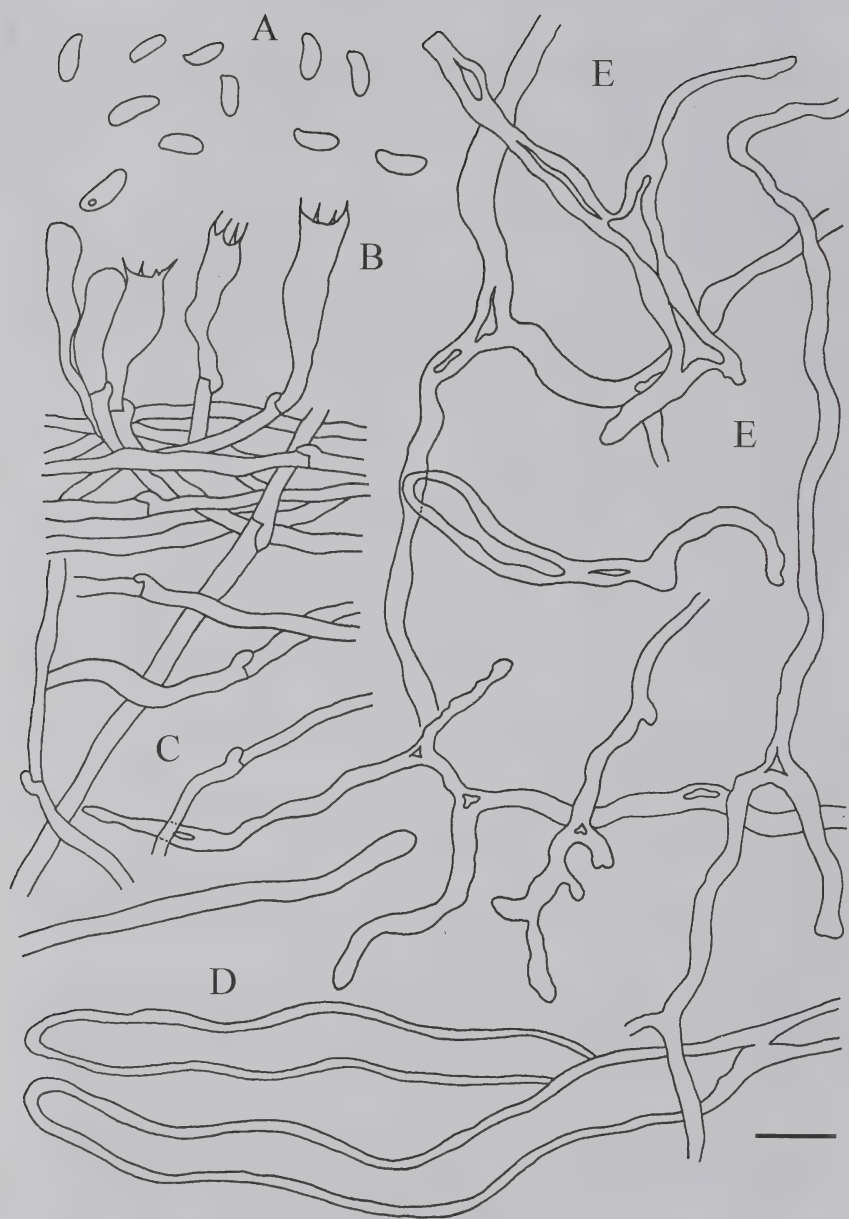


Figure 4: *Polyporus arcularius* (BAFC 33970). A) spores; B) basidia; C) generative hyphae; D) skeleto-binding hyphae (context); E) skeleto-binding hyphae (dissepiments). Scale bar = 13 μ m.

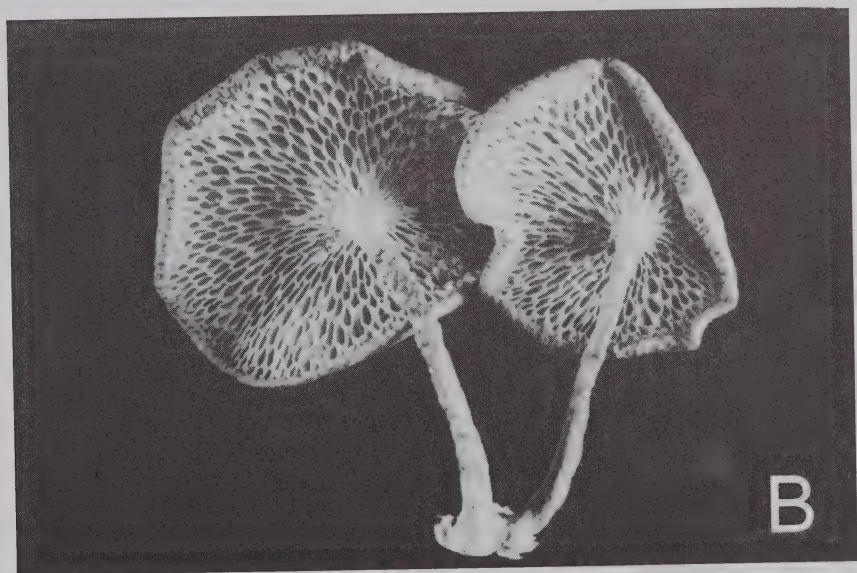


Plate 1. A) *Echinochaete brachyporus* (BAFC 28297). B) *Polyporus arcularius* (BAFC 33970).
Scale bar = 10 mm.

Rovetta & Vicari (BAFC 50656), on partially rotten trunk of *U. procera*; 4.II.1973 (BAFC 50653), on fallen branchlet of *Ligustrum lucidum*; 23.XI.1993, leg. E. Albertó & E. Fernández (BAFC 33250); San Fernando, XI-1967, leg. R. Akselman (BAFC 50649); Tigre, Paseo "Las Rosas", 18.X.1995, leg. A. Fazio (BAFC 33970). **ENTRE RÍOS:** El Palmar Nat'l Park, Colón, 8.XI.1979, leg. A. Maranta (BAFC 24512), on dead palm and spathe of *Butia yatay*; Delta, 6.III.1942, leg. J. M. Jozami (BAFC 50667). **MADAGASCAR:** leg. Goudot (**HOLOTYPE** of *F. ciliaris* **PC**). **SRI LANKA:** leg. König (**HOLOTYPE** of *P. agariceus* **K** 57282). **USA:** North Carolina: leg. M. A. Curtis 335 (**HOLOTYPE** of *F. curtisii* **K** 77602).

Remarks: *Polyporus arcularius* is easily recognized by its large, hexagonal pores and the scaly pilear surface with the margin notoriously ciliate. It is probably an introduced species in the area studied, since it has not been found in native forests.

4. *Polyporus ciliatus* Fr. : Fr., Syst. Mycol 1: 349. 1821.

FIGURE 5 and PLATE 6A

= *Polyporus platensis* Speg., An. Soc. Cient. Argent. 12: 83. 1881.- *P. penningtonii* Speg., An. Mus. Nac. Buenos Aires 8 ser. 3 vol. 1: 52-53. 1902.- *P. diabolicus* Speg., Bol. Acad. Nac. Cienc. Córdoba 11(4): 435-436. 1889.- *P. guarapiensis* Speg., An. Soc. Cient. Arg. 16: 83. 1888.- *P. pauperculus* Speg., Bol. Acad. Nac. Cienc. Córdoba 11: 483. 1889.- *P. stipitarius* Berk. & M.A. Curtis var. *pusilla* Speg., An. Mus. Nac. Buenos Aires 6: 162. 1898.

Basidiocarp annual, centrally stipitate. **Pileus** circular, umbilicate, 20-70 mm in diam. and up to 3 mm thick, coriaceous when fresh, very hard and resistant upon drying. **Pileus** surface glabrous, wrinkled when dry, brown (10YR 4/4) to light brown (10YR 6/6) or dark brown (10YR 4/3). **Margin** with large elongated cilia, incurved when dry, sometimes lacking cilia and completely entire. **Stipe** cylindric, somewhat broadened towards the base, 15-60 mm long and up to 1-5 mm in diam., fibrous, glabrous, concolorous or lighter than the pilear surface. **Hymenophore** cream coloured (2.5Y 8/4 to 8/6). **Pores** circular, angular when dry, margin fimbriate, 5-7 per mm, tubes up to 2 mm long. **Context** homogeneous, white to cream coloured, cottony-fibrous up to 2 mm thick, separated from the hymenophore by a darker line.

Hyphal system dimitic; generative hyphae clamped, hyaline, with thin- to slightly thickened walls, 2-4.5 μ m diam., inflated in the context up to 16 μ m, sclerified in the context, arranged parallel to the principal axis, and up to 9 μ m diam.; skeleto-binding hyphae thick-walled, rarely solid, 2-5.5 μ m in diam., hyaline to yellowish, moderately branched, abundant in the dissepiments. **Hymenium** formed by clavate to subglobose, 4-spored basidia, 11-22 x 4-6 μ m. **Basidiospores** cylindric to ellipsoid, thin-walled, hyaline, 5-8.5 x 2-3 μ m.

Cultural features: Nobles (1971, as *P. platensis*); David & Romagnesi (1972); Stalpers (1978).

Substrate: dead dicot wood of several genera, such as *Alnus*, *Betula*, *Populus*, *Ligustrum*, *Salix*, *Ulmus*. Also on dead conifer wood of the genus *Pinus*.

Distribution: Argentina, S. Brazil, Paraguay and Perú. Very common in temperate Eurasia and Europe, unknown from North America and Japan, according to Núñez & Ryvarden (1995b).

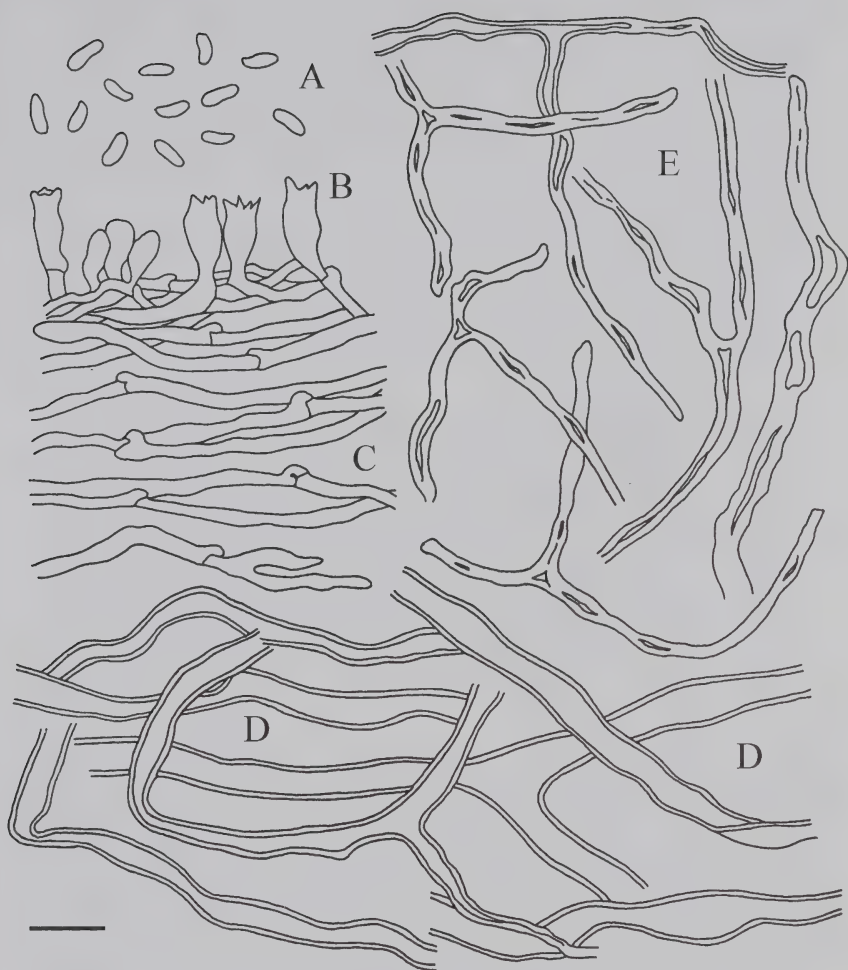


Figure 5: *Polyporus ciliatus* (BAFC 50370). A) spores; B) basidia; C) generative hyphae; D) skeleto-binding hyphae (context); E) skeleto-binding hyphae (dissepiments). Scale bar = 13 μ m.

SPECIMENS EXAMINED — **ARGENTINA. BUENOS AIRES:** *Buenos Aires City:* Reserva Costanera Sur, 14.X.1993, leg. L. Biglieri (BAFC 33253); *Buenos Aires:* Tigre, Río Sarmiento, El Ferroviario, 2.II.1975, leg. D. Cabral BA2669 (BAFC 50845); Castelar, Parque Leloir, 5.XII.1999, leg. M. B. Pildain & R. M. Silveira 442 (BAFC 50824); Ezeiza, 11.XI.1969, leg. Wright & J. R. Deschamps (BAFC 50853); 29.X.1972, leg. J. R. Deschamps (BAFC 50674), on fallen branches of *Ligustrum lucidum*; Don Torcuato, 17.IX.1981, leg. C. A. Capelli (BAFC 28510); La Plata, leg. C. Spegazzini (**HOLOTYPE** of *Polyporus platensis* LPS 25778); III.1889, leg. C. Spegazzini

(**LECTOTYPUS** of *P. stipitarius* var. *pusillus* **LPS** 25073); Llavallol, Sta. Catalina, 24.IX.1972, leg. Deschamps, Rovetta & Viccari (BAFC 31898), on fallen branch of *Ulmus procera* (BAFC 31899); 18.XII.1972, leg. ibid. (BAFC 50849), on branch of *L. lucidum*; 4.II.1973, leg. ibid. (BAFC 50846), on branch of *U. procera*; X.1995, leg. E. Albertó Ed226 (BAFC 34051); 20.X.2000, leg. E. Albertó Ed873 (BAFC 50826); Inst. Fitotécnico, 2.XI.1969, leg. J. R. Deschamps (BAFC 50852), on decayed trunk of *Ligustrum* sp.; 23.XI.1969, leg. J. R. Deschamps (BAFC 31897), on decaying *Ulmus* sp.; Punta Lara, XII.1971, leg. Merlo (BAFC 50850); leg. J. E. Wright PL1157 (BAFC 50847). **CORRIENTES**: Gral. Paz, El Tacuaral, 20.IX.1987, leg. O. Popoff 224 (CTES). **ENTRE RÍOS**: Paraná, Est. Berduq, Parque Gral. San Martín, 9.X.1977, leg. J. R. Deschamps ER2993 (BAFC 50854); Paraná Guazú, leg. S. Pennington (**HOLOTYPUS** of *P. penningtonii* **LPS** 25787). **MISIONES**: Puerto Esperanza, 20.IX.1979, leg. J. E. Wright M3215 (BAFC 24513); Ruinas de Loreto, 22.IX.1979, leg. D. Cabral & S. López M3216 (BAFC 24514). **BRAZIL. RIO GRANDE DO SUL**: Cambará do Sul, Aparados da Serra Nat'l Park, 19.XI.1987, leg. R. M. Silveira & R. T. Guerrero 046, 128, 140, 242, 248, 259 (ICN 80489, 80850, 80505, 80531, 80535, 80533); Nova Petrópolis, 8.VIII.1997, leg. R. M. Silveira 313, 314, 317, 318, 319, 320 (BAFC 50796, 50797, 50798, 50799, 50800, 50801); Porto Alegre, Lami, 20.X.1997, leg. R. T. Guerrero & Marinês (ICN102.682); Taquara, RS 2 Taquara-S. F. de Paula Hway, 21.III.1973, leg. M. H. Homrich & Lara Labarthe 686 (ICN 6370); Torres, 6.XII.1991, leg. R. T. Guerrero (ICN 80803); Viamão, Parque St.-Hilaire, 17.X.1998, leg. R. M. Silveira 420, 423, 426, 427, 428, 429, 430, 431, 432, 433, 435, 436, 437 (BAFC 50360, 50361, 50363, 50364, 50365, 50366, 50367, 50368, 50369, 50370, 50371, 50372, 50373). **SÃO PAULO**: Apiaty, VI.1881, leg. Puiggari 1032 (**HOLOTYPUS** of *P. pauperculus* **LPS** 25786); IV.1888, leg. Balansa (**HOLOTYPUS** of *P. diabolicus* **LPS** 25784). **PARAGUAY**. *Alto Paraná*, Reserva Biológica Itabó, 6 km N of Administration, 9.X.1991, leg. Popoff *et al.* 762 (CTES); Guarapi, X. 1883, leg. Balansa 4090 (**HOLOTYPUS** of *P. guarapiensis* **LPS** 25776).

Remarks: *Polyporus ciliatus* is characterized by its centrally stipitate, brown basidiocarps with very light coloured hymenophore and small pores, the pileus margin may be ciliate or not so. It is one of the most common species in the area studied. According to Núñez & Ryvarden (1995b), the spores of *P. ciliatus* measure 5-7 x 2 µm, whereas those of our materials are somewhat longer and wider, viz. 5-8.5 x 2-3 µm. The feature of having or not marginal cilia has created a confusion with *P. brumalis*, from which it may be separated by pore size. The latter species does not appear to be present in the area under study.

Jahn (1969) makes interesting observations on the differences (and confusion!) between *P. ciliatus* and *P. brumalis*, and stresses the importance of pore size to separate them. He states that *P. ciliatus* does not grow in winter, as does *P. brumalis*, and that, sometimes, they are only found together in spring. *P. brumalis* would thus be a winter fungus. In the area under study, *P. ciliatus* grows from September to June (Southern hemisphere).

5. *Polyporus curtipes* (Berk. & M.A. Curtis) Ryvarden, Synopsis Fungorum 5: 213, 1991.

FIGURE 6 and PLATE 5E
= *Favolus curtipes* Berk. & M.A. Curtis, Hooker J. Bot. 1: 234. 1849. - *Favolus cucullatus* Mont., Ann. Sci. Nat., sér. 2, 17: 125. 1842. - *Pseudofavolus cucullatus* (Mont.) Pat., Essai

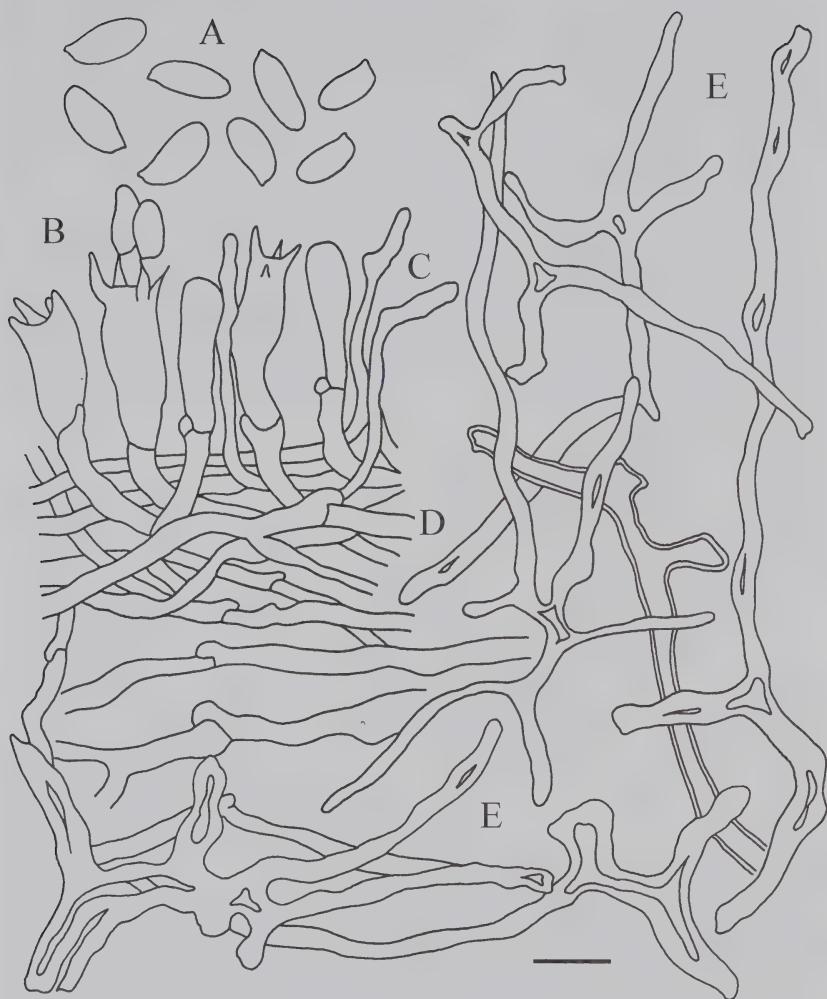


Figure 6: *Polyporus curtipes* (BAFC 50350). A) spores; B) basidia; C) dendrohyphidia D) generative hyphae; E) skeleto-binding hyphae. Scale bar = 13 μ m.

Taxon. P. 81. 1900, non *Polyporus cucullatus* Berk. & M.A. Curtis, North American Fungi n° 134, Ann. Mag. Nat. Hist., 2 ser., 12: 417. 1853; 3 ser. 4: 284. 1859.

Basidiocarp annual, solitary or several pilei imbricate growing from a single point, laterally to eccentrically adhered. **Pileus** semicircular to circular, some drying

semiconchoid, 15-65 x 15-50 mm, and 2-4 mm thick, fragile and breakable when dry. **Pileus surface** glabrous, smooth or with the print of pores, beige (10YR 7/6) to yellowish (10YR 7/6 to 7/8) or ferruginous (7.5YR 5/6) when dry. **Margin** entire, smooth, brown (7.5YR 4/4 to 5/6), involute when dry. **Stipe** as a disciform pseudostipe, 3-8 mm diam, rigid when dry, beige (10YR 7/4 to 8/4). **Hymenophore** beige (10YR 6/6 to 8/4) to light brown (7.5YR 5/4 to 5/6) when dry. **Pores** circular to angular when dry, with the margin either entire or fimbriate, (0.5-)1-2 per mm, tubes up to 3 mm long. **Context** homogeneous, corky, beige, up to 1.5 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 3-5 μ m in diam.; skeleto-binding hyphae very thick-walled, lumen visible to solid, 2.5-5 μ m in diam., and up to 7 μ m in the context, yellowish, much branched, dominating throughout the fructification, variably dextrinoid in the dissepiments. **Hymenium** formed by clavate basidia with a basal clamp, 24-47 x 6-13 μ m. **Cystidia** absent, but dendrohyphidia and cystidioles present between the basidia. **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 13-17 x 5-7 μ m.

Cultural features: unknown.

Substrate: on rotting undetermined dicots.

Distribution: NE Argentina, Cuba. Common in the tropics according to Núñez & Ryvarden (1995b)

SPECIMENS EXAMINED — **ARGENTINA.** MISIONES: Iguazú Nat'l Park, 26.IX.1979. leg. J. E. Wright M3206 (BAFC 25176); lower circuit of falls, 5.IV.1984, leg. Job & Rajchenberg M3557 (BAFC 30023); Sendero Macuco, 2.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 395 (BAFC 50350); forbidden zone, 300 m from boundary, 7.IV.1984, leg. Wright, Rajchenberg & Job M3621 (BAFC 30024). CUBA: leg. Ramón de la Sagra & C. Wright (**HOLOTYPE** of *Favolus cucullatus* **PC**).

Remarks: *Polyporus curtipes* is characterized by its large isodiametric pores, very thin context and very large spores; the latter separating it from other species with large pores.

This species is morphologically close to *P. tenuiculus* but in isoenzymatic analysis these species are easily distinguished (Silveira et al., 2003).

Montagne (1842) described this taxon as *Favolus*. For the reasons given above on the genus *Polyporus*, we consider that *F. cucullatus* Mont. should be included in *Polyporus*. However, although this is a proritary name it cannot be used in *Polyporus* because it is preoccupied by *P. cucullatus* Berk. & M.A. Curtis; for this reason Ryvarden (1991) proposed the new combination *P. curtipes* as the correct name for the species.

6. *Polyporus cyathiformis* Lév., Ann. Sci. Nat. Bot., sér. 3, 2: 181. 1844.

FIGURE 7 and PLATE 6E

= *Polyporus craterellus* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 305. 1868.

Basidiocarp annual, eccentrically stipitate, circular to flabelliform, infundibuliform or plane, 25-80 mm in diam., and up to 4 mm thick, fragile and breakable upon drying. **Pileus surface** glabrous, wrinkled when dry, beige (10YR 6/6) to brown (7.5YR 5/6 to 4/4) when dry. **Margin** entire, sometimes incurved when dry. **Stipe** cylindric, 15-50 mm long and 2-10 mm in diam., rigid when dry, glabrous, concolorous with the

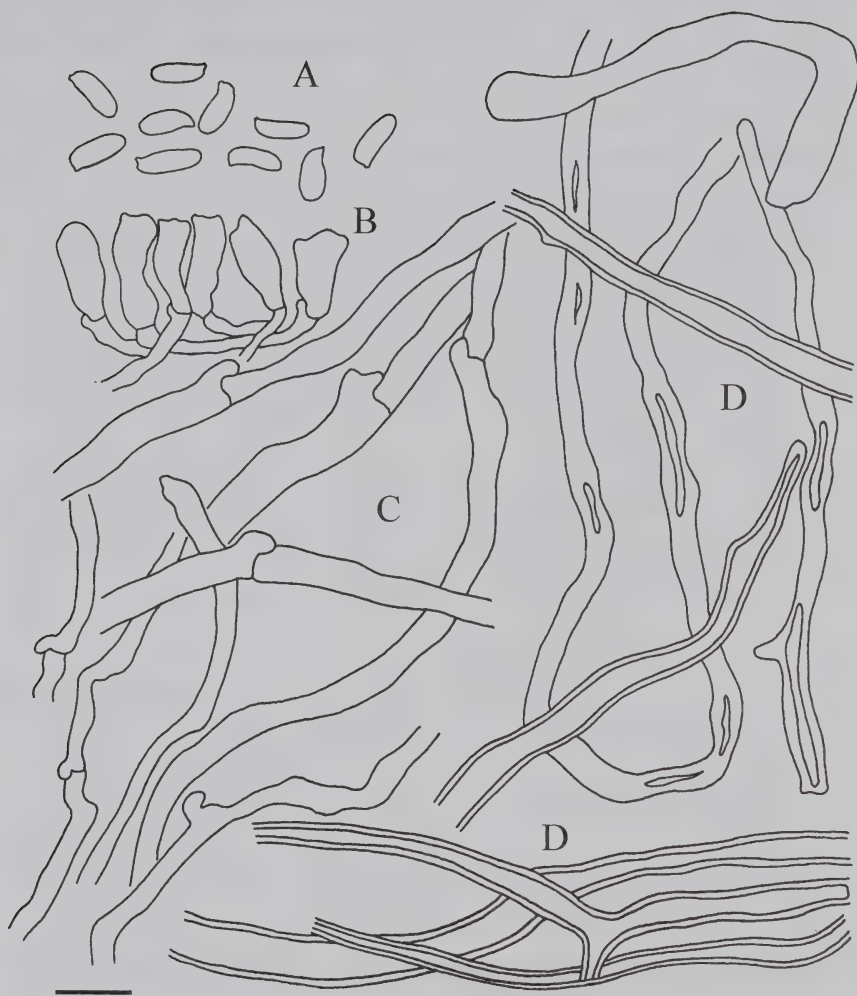


Figure 7: *Polyporus cyathiformis* (BAFC 30586). A) spores; B) basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μ m.

hymenophore. **Hymenophore** beige (10YR 7/4) to light brown (10YR 5/6) or brown (7.5YR 5/4). **Pores** circular to angular, 4-7 per mm, reaching almost to the base of the stipe, tubes up to 1.5 mm long. **Context** homogeneous, cottony, beige, up to 3 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 3-5 μ m in diam., inflated in the context up to 14 μ m in diam., dominating throughout the

basidiome; skeleto-binding hyphae thick-walled, lumen visible, 4-10 μm in diam., hyaline to yellowish, hardly branched, present in the context. **Hymenium** formed by clavate, 4-spored basidia, 20-25 x 5-7 μm . **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 8-10 x 3-4 μm .

Cultural features: unknown.

Substrate: dead undetermined dicots and gymnosperms of the genera *Araucaria* and *Pinus*.

Distribution: Bolivia, S Brazil, Cuba and Dominican Republic.

SPECIMENS EXAMINED — **BOLIVIA.** LA PAZ: Nor-Yungas, Capillaria, alt. 1800-1900 masl, 22-II.1956, leg. Singer B1324 (BAFC 30586), on dicot trunk out of forest. **BRAZIL.** PARANÁ: Campo Largo, Estancia Ouro Fino, 21.XII.1988, leg. A. de Meijer 1190 (Herb. Meijer), on rotten *Pinus* trunk, in *Pinus* plantation; Foz do Iguaçu, Cataratas do Iguaçu Nat'l Park, 31.XII.1992, leg. A. de Meijer 2396 (Herb. Meijer); S of Iratí, São Paolino, alt. 960 masl, 17.I.1981, leg. Plank & Broggi 3449 (BAFC 26558), on root of *Araucaria angustifolia* stump. **CUBA.** leg. C. Wright 377 (**HOLOTYPE** of *Polyporus craterellus* K 57285).

Remarks: *Polyporus cyathiformis*, whose type, according to Ryvarden, is not extant, has not been considered by many authors. Most have preferred to use Berkeley & Curtis' epithet. However, and taking into account Lloyd's (1910) statement—who apparently saw the types—we consider that Lévillé's name is the correct name for the species, and our materials coincide with his description (Lévillé, 1844).

7. *Polyporus dictyopus* Mont., Ann. Sci. Nat., sér. II, 3: 349. 1835.

FIGURE 8 and PLATE 5A

= *P. rhizomorpha* Mont., Ann. Sci. Nat., sér. II, 13: 202. 1840. — *P. infernalis* Berk., Hooker London J. Bot. 2: 637. 1843. — *P. blanchettianus* Berk. & Mont., Ann. Sci. Nat. sér. II, 11: 238. 1849. — *P. diabolicus* Berk., Hooker London J. Bot. 8: 174. 1856. — *P. rufoatratus* Berk., Hooker London J. Bot. 8: 174. 1856. — *P. vernicosus* Berk., Hooker London J. Bot. 8: 175. 1856. — ? *P. decolor* Berk., Hooker London J. Bot. 8: 195. 1856. — *P. nephridius* Berk., Hooker London J. Bot. 8: 195. 1856. — *P. hydniceps* Berk. & M.A. Curtis, Linn. Soc. Bot. 10: 305. 1868. — *P. dibaphus* Berk. & M.A. Curtis, Grevillea 1: 32. 1872. — *P. parvimarginatus* Speg., An. Soc. Cient. Argent. 16: 280. 1883. — *P. puiggarii* Speg., Bol. Acad. Nac. Cienc. Córdoba 11: 141. 1889.

Basidiocarp annual, eccentric to sublaterally stipitate. **Pileus** flabelliform to circular or semiinfundibuliform, 20-50 x 15-52 mm and 1-3 mm thick, coriaceous when fresh, rigid and woody when dry. **Pileus surface** glabrous, smooth or with fine radial striae, brown (2.5YR 3/6) to vinaceous brown (2.5YR 3/4), or dark vinaceous brown (5YR 2/2). **Margin** entire, smooth or wrinkled when dry. **Stipe** cylindric, sometimes slightly broadened at the base, 10-70 mm long and 1-6 mm in diam., woody, rigid when dry, dark brown to black (5YR 3/2 to 2/2). **Hymenophore** light brown (10YR 6/4) to grayish (10YR 5/3 to 4/2). **Pores** circular to angular when dry, decurrent on the stipe, 6-9 per mm, tubes 0.5-2 mm long. **Context** homogeneous, corky to cottony, cream coloured to beige, 0.5-1 mm thick.

Hyphal system dimitic; generative hyphae clamped, difficult to observe in dry specimens, hyaline, thin-walled, 2-5 μm in diam.; skeleto-binding hyphae with much

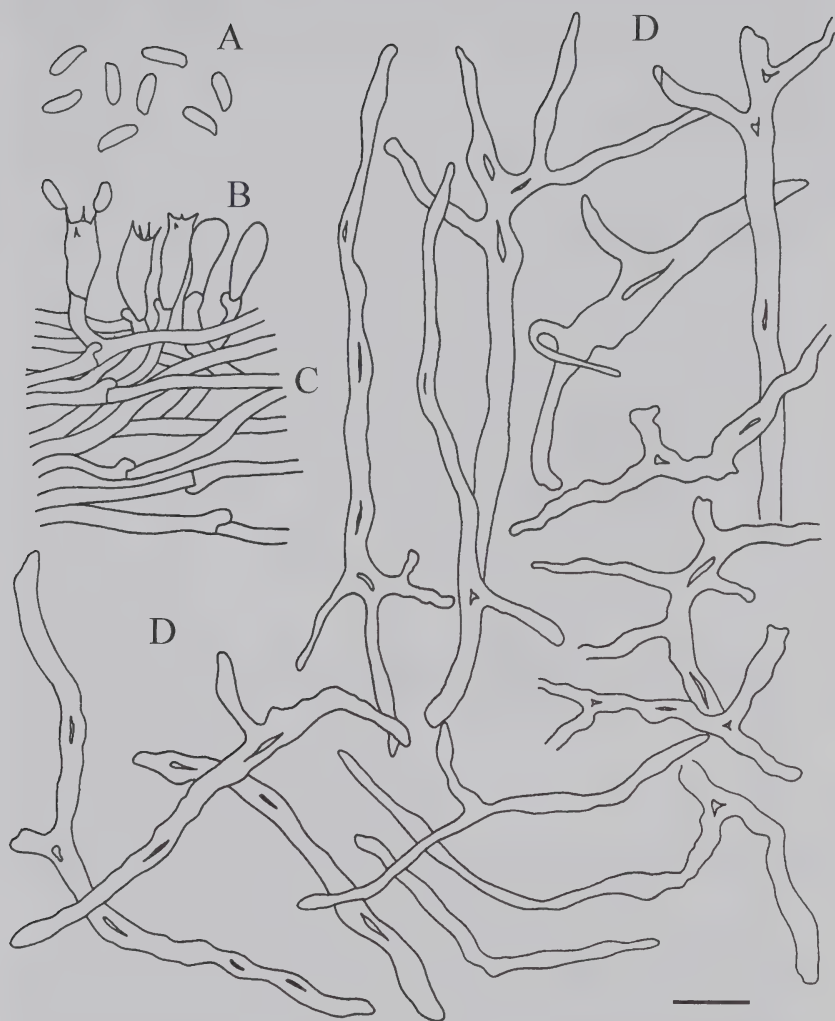


Figure 8: *Polyporus dictyopus* (BAFC 50783). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μm .

thickened walls, lumen visible to solid, 2-7 μm in diam., pale yellowish, branched and tortuous, dominating throughout the pileus, dextrinoid in the dissepiments. **Stipe** cortex formed by a basal layer of much differentiated hyphae, resembling pieces of a jig-saw puzzle, irregularly polygonal and much appressed, disguised by a melanoid substance

which includes them as a basal band, and an external layer of hyphae with terminal cells, thick-walled, cylindric-clavate, arranged in a palisade, $10\text{--}13 \times 4\text{--}7 \mu\text{m}$. **Hymenium** formed by clavate, 4-spored basidia, $13\text{--}20 \times 4\text{--}6 \mu\text{m}$. **Basidiospores** cylindrical to ellipsoid, thin-walled, hyaline, $6\text{--}8 \times 2\text{--}3 \mu\text{m}$.

Cultural features: unknown.

Substrate: dead wood of undetermined dicots.

Distribution: Argentina, Bolivia, Brazil, Chile, Cuba, French Guyana, Guyana, Panamá, Paraguay and Venezuela. Pantropical according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — ARGENTINA. MISSIONES: Garuhapé, brook banks near Arboretum, 1.II.1962, leg. Wright *et al.* (BAFC 50827); Iguazú Nat'l Park, route 101 at Park entrance, 11-IV.1984, leg. Rajchenberg & Job M3736, M3750 (BAFC 30134, 30151); Yacuy, nr police squad., 22.IX.1984, leg. D. Job M3786 (BAFC 30414); Sendero Macuco, 22.IX.1984, leg. Job & Rajchenberg M3573 (BAFC 30047); 8.IV.1984, leg. Wright, Rajchenberg & Job M3652, M3677 (BAFC 30075, 30088); 23.IX.1984, leg. D. Job M3811, M3807 (BAFC 30412, 30416); 2.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 398 (BAFC 50783); 8.IV.1984, leg. Wright, Rajchenberg & Job M3673 (BAFC 30087); 23.IX.1984, leg. D. Job M3807, M3811 (BAFC 30416, 30412); forbidden zone, 300 m from boundary, 7.IV.1984, leg. Wright, Rajchenberg & Job M3630 (BAFC 30055). **Salta:** Gral. San Martín, Yacuy, 6.II.1965, leg. C. E. Gómez (BAFC 50830). **TUCUMÁN:** Tafi Viejo, 7.II.1965, leg. Bettucci & Guerrero (BAFC 50831). **BOLIVIA.** BENI: Vaca Díez, Guayamerín, 8.III.1956, leg. Singer B1728 (LIL); 23.II.1956, leg. Singer B1386 (LIL). **BRAZIL.** leg. Spruce 195 (**HOLOTYPE** of *Polyporus diabolicus* K 41844); 164 (**HOLOTYPE** of *P. nephridius* K 60285); **BAHIA:** leg. Blanchet (**HOLOTYPE** of *P. blanchettianus* PC); **MINAS GERAIS:** Arrial des Mercês, X.1840 (**HOLOTYPE** of *P. infernalis* K 60280); **PARANÁ:** Curitiba, Parque Barigüí, 28.XI.1990, leg. A. de Meijer 1879 (Herb. Meijer); Morretes, Parque Morumbi, BR 277, 13.IV.1991, leg. A. de Meijer 1928 (Herb. Meijer); **RIO GRANDE DO SUL:** Cambará do Sul, Aparados da Serra Nat'l Park, 19.XI.1987, leg. R. M. Silveira & R. T. Guerrero 041, 042 (ICN 80491, 80492); Canela, Parque do Pinheiro Grosso, 22.I.1997, leg. R. M. Silveira 312 (BAFC 50786); Tenente Portela, Parque Turvo, 7.VII.1975, leg. Maria Alves (BAFC 50834; ICN 6442); Torres, 22.XII.1979 (ICN 102073); Ríó do Terra, 28.II.1978, leg. U. Dias (ICN 102115); Viamão, Parque St.-Hilaire, 19.VI.1996, leg. R. M. Silveira 303 (BAFC 50787); **SANTA CATARINA:** Florianópolis, Saco Grande, UFSC-UCAD, 16.I.1998, leg. R. M. Silveira 348, 349 (BAFC 50788, 50789); São PAULO: Apiahy, IV.1888, leg. J. Puiggari (**HOLOTYPE** of *Polystictus puiggarii* LPS 25780); Guarapi 1880, leg. Balansa 3408 (**HOLOTYPE** of *Polyporus parvmarginatus* LPS 25206); Panuré, leg. Spruce 47 (**HOLOTYPE** of *P. decolor* K 57286); 196 ex Herb. Berkeley (**HOLOTYPE** of *P. rufo-atratus* K 60287); (**HOLOTYPE** of *P. vernicosus* K 60294). **CHILE.** Corral, XII.1905, leg. R. Thaxter (BAFC 50828); Juan Fernández: leg. Bertero (**HOLOTYPE** of *P. dictyopus* PC). **CUBA.** leg. C. Wright 354 (**HOLOTYPE** of *P. hydnceps* K 57293). **FRENCH GUYANA.** Leprieur 573 (**HOLOTYPE** of *P. rhizomorpha* PC). **PANAMA.** Chiriquí, Valley of upper Río Chirique, 7.IX.1935, leg. Martin 2678 (BPI, BAFC 29520), 1600–1800 masl. **USA.** Alabama: leg. Peters (**HOLOTYPE** of *P. dibaphus* K 57287).

Remarks: The study of the holotypes of all the species names given above confirms their synonymy, which is shared by other workers (Núñez & Ryvarden, 1995b). Núñez & Ryvarden (op. cit.) consider *P. decolor* a synonym of *P. dictyopus*. However, we are

unable to confirm this synonymy: the type material is in such poor condition and the hyphae so collapsed that it is impossible to find skeleto-binding hyphae, the primary criterion for identifying the species. *Polyporus melanopus* also has a pileus surface brown to vinaceous brown, a dark stipe and small pores and some collections may be identified as *P. dictyopus*. Nevertheless, *P. melanopus* belongs to temperate cold zones and grows on wood of *Nothofagus*, whereas *P. dictyopus* is from tropical to subtropical zones and associated with various species of angiosperms.

8. *Polyporus gayanus* Lév., Ann. Sci. Nat., sér. III, 5: 54. 1846.

FIGURE 9 and PLATE 5C

= *Polyporus fuegianus* Speg., Bol. Acad. Nac. Cienc. Córdoba 11: 161. 1887.

Basidiocarp annual, dimidiate, flabelliform to conchoid or irregularly undulate, 45-75 x 35-55 mm and up to 5 mm thick when dry, resistant to woody, hard upon drying. **Pileus surface** glabrous, wrinkled when dry, sometimes slightly striate, light brown (10YR 6/6) to darker (10YR 5/4) when dry. **Margin** entire or lobed, recurved when dry. **Stipe** absent, adhered to substrate by a mere notch in the pileus margin, or by a more or less distinct mucro. **Hymenophore** cream coloured to light brown (10YR 7/4 to 6/4), or brown (10YR 4/4). **Pores** circular to angular when dry, 2-4 per mm, dissepiments with denticulate borders, tubes up to 2 mm long. **Context** homogeneous, cottony, white to cream coloured, up to 3 mm thick.

Hyphal system dimitic; generative hyphae clamped, hard to observe in dried specimens, thin-walled, hyaline, 2-5 μm in diam.; skeleto-binding hyphae thick-walled to solid, with the trunk branched, 2-6 μm in diam. and up to 8 μm in the context, hyaline to pale yellowish, dominating throughout the context and dissepiments. **Hymenium** formed by clavate, 4-spored basidia, 15-22 x 5-8 μm . **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 8.5-10.5 x 2.5-3.5 μm .

Cultural features: Wright & Deschamps (1972); Rajchenberg & Greslebin (1995).

Substrate: dead wood of species of *Nothofagus*.

Distribution: S Argentina and Chile. Reported from New Zealand, according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — **ARGENTINA.** **CHUBUT:** Lago Puelo Nat'l Park, N bank, W piedmont of Valle de las Lágrimas, 4.V.1998, leg. R. M. Silveira & M. Rajchenberg 366 (BAFC 50745), on dead branch of *Nothofagus dombeyi* ("coihue"); Futaleufú, Cerro de la Torta, in *N. pumilio* woods, 5.V.1998, leg. R. M. Silveira and A. Greslebin 368, 369, 370, 371, 372, 373, 374 (BAFC 50746, 50747, 50748, 50749, 50750, 50751, 50752), on dead branches of *N. pumilio* ("lenga"); Los Alceres Nat'l Park, Lago Futalaufquen, path to Lago Krugger, 6.V.1998, leg. R. M. Silveira and M. Rajchenberg 375 (BAFC 50753); Lago Menéndez, S arm, 8.V.1998, leg. Ibid. 379 (BAFC 50754); Lago Rivadavia, camping area, 9.V.1998, leg. Ibid. 380, 381, 382, 383, 384 (BAFC 50755, 50756, 50757, 50758, 50759), on branches of *N. dombeyi* ("coihue"). **NEUQUÉN:** Lanin Nat'l Park, Lago Echulaufquen, II.1984, leg. C. A. Capelli (BAFC 29559); leg. Singer M1722 (BAFC 22336); Lago Frías (P. Alegre), 10.V.1961, leg. I. Gamundí (BAFC 21189); Quettrihué, 11.XI.1966, leg. Singer M6061 (BAFC 22450); 20.I.1976, leg. J. R. Deschamps (BAFC 50761), on branchlets of *N. dombeyi*; Villa La Angostura, 22.I.1971, leg. Pablo Wright (BAFC 22633), on dead branch of *N. dombeyi*.

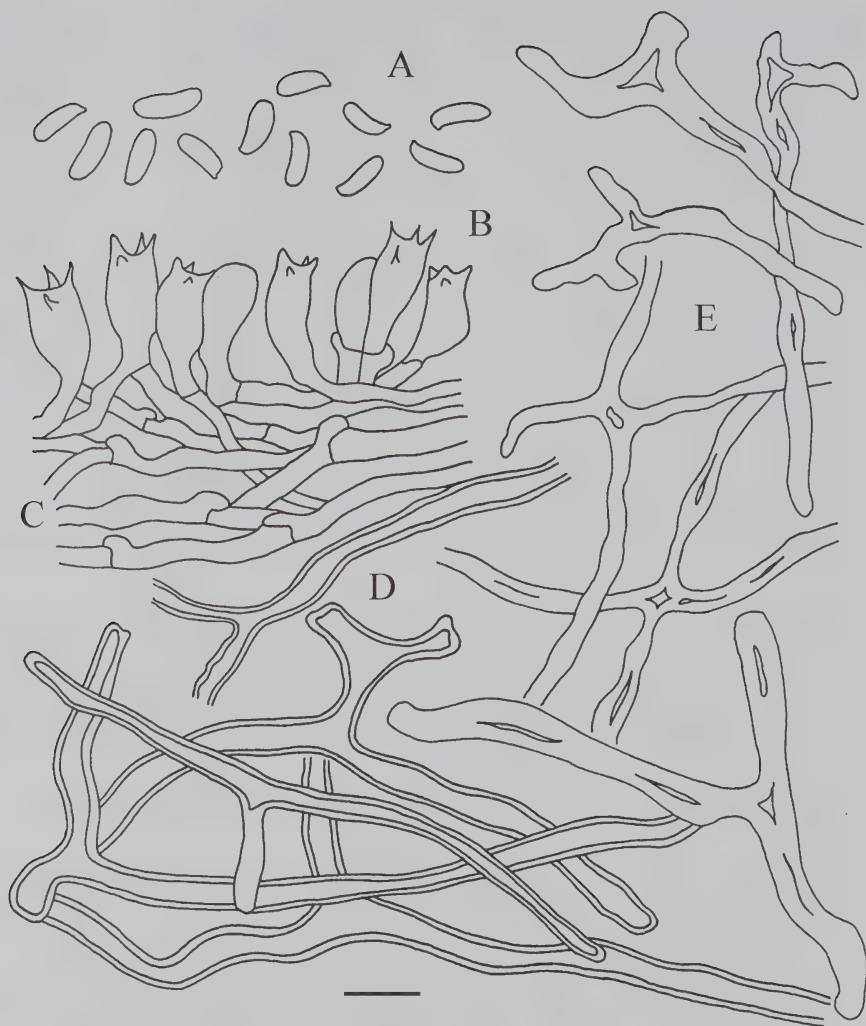


Figure 9: *Polyporus gayanus* (BAFC 50749). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae (context); E) skeleto-binding hyphae (dissepiments). Scale bar = 13 μm .

RÍO NEGRO: Cerro Catedral, 25.IV.1965, leg. Singer 5182B (BAFC 22449); Lago Roca, II.1981, leg. C. A. Capelli (BAFC 26685), on *Nothofagus*. **TIERRA DEL FUEGO:** Tierra del Fuego Nat'l Park, leg. J. E. Wright (BAFC 30666), on trunk of *Nothofagus*, site named Mallin (BAFC 30669); Lago El Indio, 29.I.1973, leg. Wright, Godeas & Del Busto (BAFC 22784), in reconstituted *N. pumilio* woods, road to Lapataia, passing the bridge; Lapataia, road to 2 de Mayo, II.1974, leg. C. E. Gómez (BAFC 50762); Glaciar Martial, 21.II.2000, leg. V. Suárez 6

(BAFC 50719), on dead fallen trunk, 800 m from entrance; Kosovo, 27.X.1989, leg. C. Loguercio Leite (BAFC 50760), on *Nothofagus*, Laguna Negra, 17.II.1974, leg. C. E. Gómez (BAFC 23218), on rotten trunk of *Nothofagus*; Ea. Nueva Argentina, 22.II.1950, leg. Singer M186 (BAFC 22634); USHUAIA: V.1882, leg. Spegazzini (**HOLOTYPE** of *Polyporus fuegianus* LPS 24999).

Remarks: The conchoid basidiocarp lacking a proper stipe, and the large pores characterize this species, which is restricted to temperate zones with *Nothofagus* woods. Ryvarden (1991) erroneously synonymized the name *P. gayanus* with *Trametes marianna* (Pers.) Ryvarden, but it is a true *Polyporus*. Núñez & Ryvarden (1995b) consider it a good species.

9. *Polyporus guianensis* Mont. var. *guianensis*, Ann. Sci. Nat., sér. II, 13: 201. 1840.

FIGURE 10 and PLATE 2A

= *Favolus melanopus* Mont., Ann. Mag. Nat. Hist, IV, 1: 136. 1854.- *Polyporus aemulans* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 304. 1868.- *P. seminigrata* Cooke, J. Linn. Soc. Bot. 15: 377. 1876.

Basidiocarp annual, central to sublaterally stipitate. **Pileus** circular to flabellate and infundibuliform, 23-25 mm in diam., 1-3 mm thick, coriaceous when fresh, rigid or breakable when dry. **Pileus surface** glabrous, smooth or with very fine radial striae, brown (5YR 5/6) to vinaceous brown (2.5YR 3/4) or beige (10YR 7/4). **Margin** entire, smooth. **Stipe** cylindric, sometimes slightly broadened at the base, 10-40 mm long, 2-4 mm in diam., woody, rigid when dry, dark brown (10YR 3/3 to 5YR 2/2). **Hymenophore** beige (10YR 7/4 to 6/4). **Pores** circular to angular, radially elongated, decurrent on the stem, 1-4 per mm, tubes 1-2 mm long. **Context** homogeneous, cottony, cream coloured to beige, up to 1 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 2-5 μ m in diam.; skeleto-binding hyphae very thick-walled, lumen visible to solid, 3-5.5 μ m in diam., and up to 8 μ m in the context, yellowish, branched and tortuous, dominating throughout the pileus. **Stipe** cortex formed by a single visible layer, composed of much appressed cells, appearing as an epithelium, more isodiametric outwardly, finally appearing in the surface as inflated elements provided with digitiform projections or short horns, 13-15 x 4-11 μ m, all the layer masked by a melanoid substance. **Hymenium** formed by clavate, 4-spored basidia, 22-35 x 6-8 μ m. **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 8-12 x 2.5-4 μ m.

Cultural features: Núñez & Ryvarden (1995b).

Substrate: dead wood of undetermined dicots.

Distribution: Argentina, Brazil, Chile, Colombia, Cuba, French Guyana, Guyana, Paraguay and Venezuela. According to Núñez & Ryvarden (1995b) it occurs in tropical Asia and South America, apparently not common.

SPECIMENS EXAMINED — **ARGENTINA.** MISIONES: Iguazú Nat'l Park, 16.V.1993, leg. Wright, Moreno & Altés (BAFC 33642); road to Apepú, 8.III.1979, leg. Wright, Deschamps & Del Busto M3380 (BAFC 31989). TUCUMÁN: Horco Molle, 9.IV.1987, leg. D. Job 3927 (BAFC); Tafí Viejo, 7.II.1965, leg. Bettucci & Guerrero (BAFC, 2 collections). **BRAZIL.** AMAZONAS: Juruá, 1900, leg. Ule (ex NY, BAFC 27462); BAHIA: leg. Torrend (CGL Herb. 43255, BPI); PARÁ: Obydos, 1874, leg. Traill

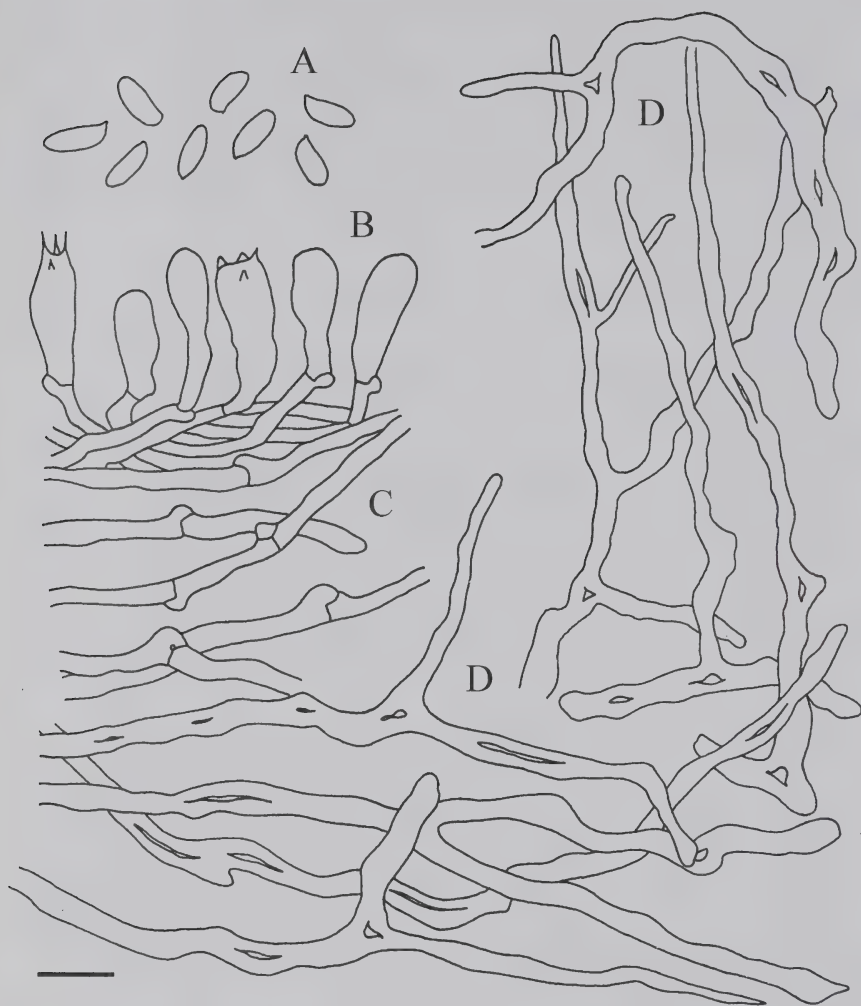


Figure 10: *Polyporus guianensis* (BAFC 50839). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μ m.

102 (**HOLOTYPUS** of *Polyporus seminigrita* **K** 60289); **PARANÁ:** Curitiba, Parque Barigüi, 26.I.1998, leg. R. M. Silveira & A. de Meijer 355, 356, 357, 358, 359 (BAFC 50795, 50807, 50808, 50809, 50810). **CUBA.** leg. C. Wright 91 (**HOLOTYPUS** of *P. aemulans* **K** 57281). **FRENCH GUYANA.** Cayenne, leg. Leprieur 538 (**HOLOTYPUS** of *P. guianensis* **PC**); leg. Leprieur (**HOLOTYPUS** of *Favolus melanopus* **PC**); Montsinery, concession des F.R.G., piste des Risquetonit, 15 km from DR5, 12.XII.1979, leg. H. Jacquenin 2437 (ex **PC**, BAFC 26953). **VENEZUELA.** Isla El Ratón, 31.V.1940, leg. L. Williams 13200 (BAFC 50837).

10. *Polyporus guianensis* var. *puttemansii* (Henn.) R.M. Silveira & J.E. Wright, comb. nov.

FIGURE 10 and PLATE 2B

Basionym: *Polyporus puttemansii* Henn., Hedwigia 43: 200, 1904.

It is distinguished from var. *guianensis* by the following characters: pileus large, 20-110 mm in diam. and 10-80 mm high, margin concolorous with the pileus surface, stem insertion with a tendency to be central; pores with a tendency to be more ellipsoid to angular, and of larger size, 0.5-1.5 per mm.

SPECIMENS EXAMINED — **ARGENTINA.** MISIONES: Bernardo de Irigoyen, 27.II.1960, leg. M. Ledda & R. T. Guerrero 94 (BAFC 50838); Iguazú Nat'l Park, route 101 to Sto. Domingo, left of road towards Yacuy, 9.IV.1984, leg. Wright, Rajchenberg & Job M3721 (BAFC 30122); **TUCUMÁN:** Horco Molle, nursery, 11.IV.1987, leg. D. Job & A. Hladki 3992 (BAFC 50839). **BRAZIL.** PARANÁ: Curitiba, Parque Barreirinha, 19.I.1989, leg. A. de Meijer 1197 (BAFC 50840); Parque Marumbi, 7.V.1992, leg. A. de Meijer 2250 (BAFC 50844); **RIO GRANDE DO SUL:** Cambará do Sul, Aparados da Serra Nat'l Park, 27.XII.1988, leg. R. M. Silveira & R. T. Guerrero 162 (ICN 80493).

Remarks: Although some authors consider Hennings' epithet as synonymous with *P. guianensis*, we have treated *P. puttemansii* as a variety because the differences from the type appear stable and have been found in several collections (see Table 1). Lloyd (1910) reached a similar conclusion.

11. *Polyporus lepieurii* Mont., Ann. Sci. Nat. sér. II, 13: 203. 1840.

FIGURE 11 and PLATES 2C, 5D

= *Polyporus tephromelas* Mont., Ann. Sci. Nat. sér. II, 13: 203. 1840.

Basidiocarp annual, lateral to sublaterally stipitate. **Pileus** flabelliform, 17-50 x 23-35 mm and 0.5-1 mm thick, coriaceous when fresh, breakable when dry. **Pileus surface** glabrous, smooth or with fine radial striae, sometimes concentrically undulate; brown (10YR 4/3 to 5/6) to tobacco brown (10YR 4/4). **Margin** lobate, concolorous with the surface of pileus. **Stipe** cylindric, sometimes slightly broadened at the base, 5-50 mm long, 1-3 mm in diam., fragile to woody, breakable to rigid when dry, dark brown (10YR 3/2) to black (10YR 2/2), and may elongate to form rhizomorphs. **Hymenophore** brown (10YR 5/4) to tobacco brown (10YR 3/4 to 4/4). **Pores** circular to angular when dry, uniformly distributed, 5-9 per mm, tubes 0.1-0.2 mm long. **Context** homogeneous, cottony, brown when dry, up to 1 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 2-4 μ m in diam.; skeleto-binding hyphae with very thickened walls, lumen visible to solid, 2.5-4 μ m diam. and up to 9 μ m in the context, yellowish, branched and tortuous, dominating throughout the pileus, variably dextrinoid in the dissepiments. **Stipe cortex** formed by a single layer composed of much appressed, polyhedric cells with sinuous walls, forming outwardly large, cylindric-clavate, thick-walled projections, 4-5.6 μ m diam, and bulbiform endings with a much thinner, blunt rostrum, 1-2 μ m diam; all the layer is masked by a melanoid substance. **Hymenium** formed by clavate, 4-spored basidia, 17-23 x 4-6 μ m. **Basidiospores** subcylindric to ellipsoid, thin-walled, hyaline, 7-11 x 2.5-4 μ m.

Cultural features: unknown.

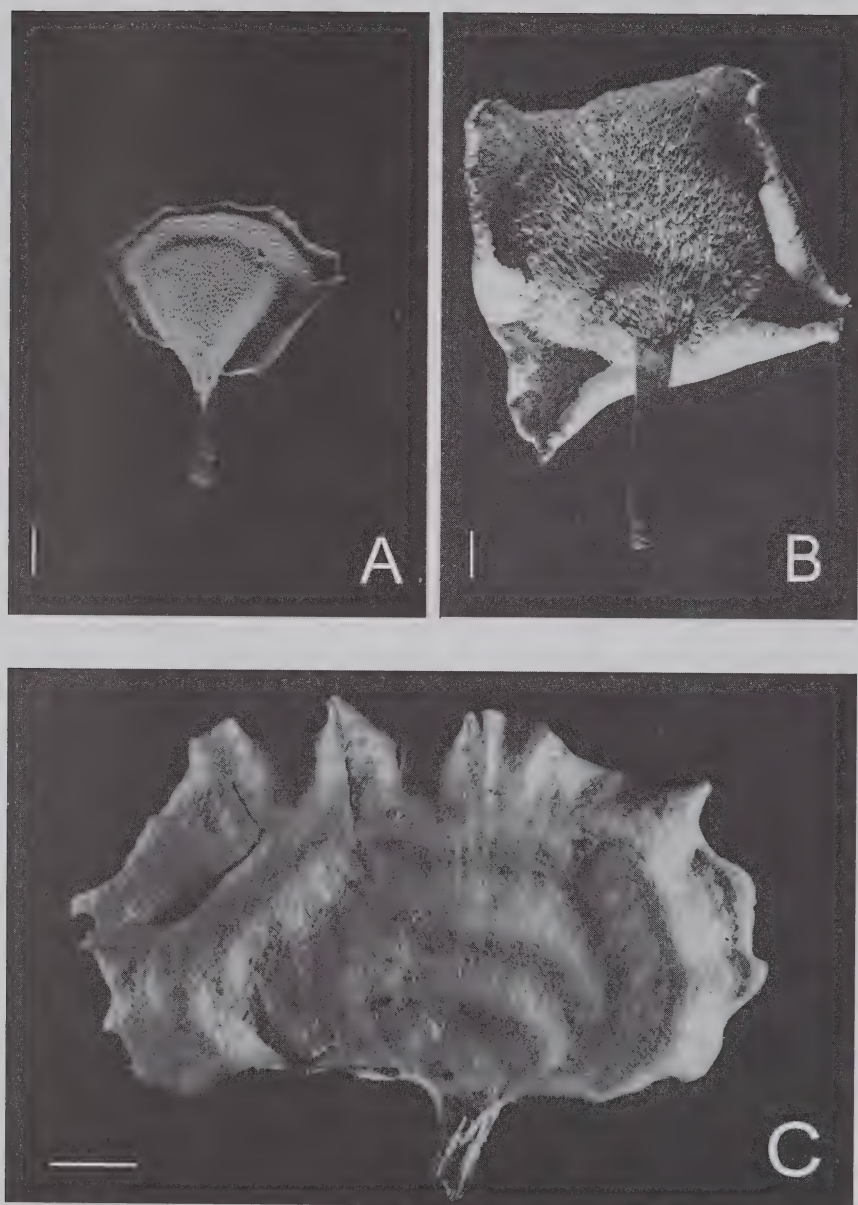


Plate 2. A) *Polyporus guianensis* var. *guianensis* (BAFC 50809). B) *P. guianensis* var. *puttemansii* (BAFC 50844). C) *P. leprieurii* (Guyana – FH). Scale bar = 10 mm.

Substrate: dead wood of undetermined dicots.

Distribution: NE Argentina, Brazil, Colombia, Costa Rica, French Guyana, Guyana, Perú, Surinam, Trinidad and Venezuela. According to Núñez & Ryvarden (1995b), it is a tropical to subtropical species of South America and E Asia.

SPECIMENS EXAMINED—**ARGENTINA.** MISIONES: Iguazú Nat'l Park, 5.III.1982, leg. M. Grosso M3493 (BAFC 28296); route 101, entrance to Park, 11.IV.1984, leg. Rajchenberg & Job M3749 (BAFC 30143); Sendero Macuco, 5.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 418 (BAFC 50784). **BRAZIL.** AMAZONAS: VIII, 1901, leg. E. Ule 2760 (FH); VII.1961, leg. H. Cordeiro (ICN 102497); **PARANÁ:** Morretes, P. E. Marumbi, 15.III.1987, leg. A. de Meijer 796 (BAFC 31307); **RIO GRANDE DO SUL:** Barra do Ribeiro, Horto Florestal Barba Negra (Riocell), 13.XI.1996, leg. R. M. Silveira 302 (BAFC 50785) on stump of felled *Eucalyptus*; **SANTA CATARINA:** Florianópolis, Saco Grande UFSC-UCAD, 16.I.1998, leg. R. M. Silveira 350, 351, 353 (BAFC 50790, 50791, 50792); Prov.?, Araguaí, leg. Furtado (ex SP). **COSTA RICA:** Jocásal, 1.VI.1928, leg. Karl A. Danielson 181 (BAFC 50324). **FRENCH GUYANA:** Cayenne, leg. Leprieur 531 (**HOLOTYPE** of *Polyporus lepieurii* **PC**); leg. Leprieur (**HOLOTYPE** of *P. tephromelas* **PC**). **GUYANA:** 17.XII.1923 (FH).

Remarks: *Polyporus lepieurii* is characterized by its flabelliform basidiocarp, with a black, lateral stipe, tobacco brown pileus, and small pores. The closest species is *P. guianensis* whose larger pores allow an easy separation.

Table 1. Comparison between *P. lepieurii*, *P. guianensis*, and *P. guianensis* var. *puttemansii*

	<i>P. lepieurii</i>	<i>P. guianensis</i> var. <i>guianensis</i>	<i>P. guianensis</i> var. <i>puttemansii</i>
Pileus colour	brown to tobacco brown	beige to brown	cream colour to beige
Margin colour	concolorous with pileus surface	vinaceous brown	concolorous with pileus surface
Stipe insertion	lateral to sublateral	central to sublateral	central
Pore arrangement	uniformly distributed	radially elongated	radially elongated
Pore shape	Circular to angular	elongated hexagonal	ellipsoid to angular
Pore size	5-9 per mm	1-4 per mm	0.5-1.5 per mm
Spore size	(5.5) 6.5-10 x 2-4 μ m	8.5-12 x 3-4 μ m	8-10.5 x 2.5-4 μ m
Q (spores)	2.5-3 μ m	2.1-3.4 μ m	2.3-3.4 μ m
IKI	dissepiments dextrinoid	negative	negative

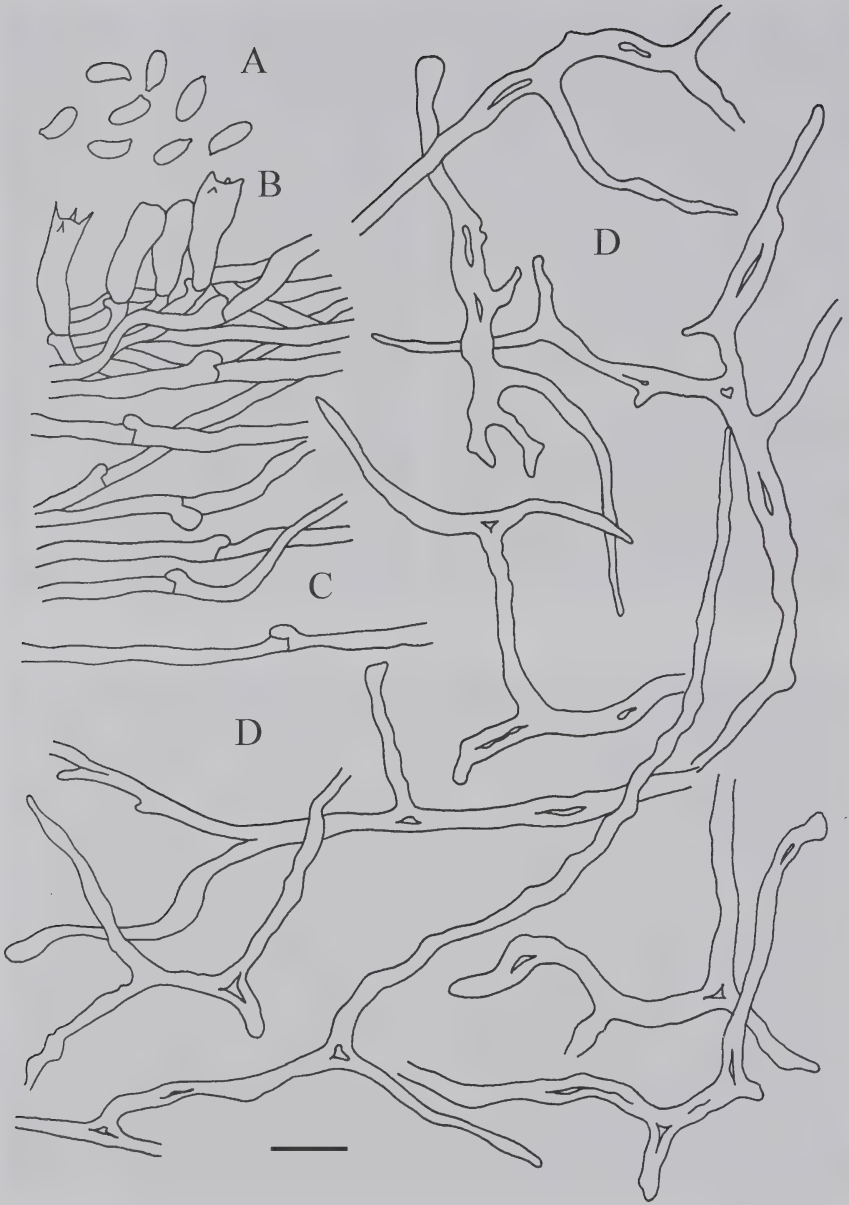


Figure 11: *Polyporus leprieurii* (Ule 2760). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μ m

12. *Polyporus melanopus* (Pers. : Fr.) Fr., Syst. Mycol. 1: 347. 1821.

FIGURE 12 and PLATE 5B

= *Boletus melanopus* Pers., Tent. Disp. Meth. Fung.: 70, 1797.- *Polyporus fissus* Berk., Hooker London J. Bot 6: 318. 1847.

Basidiocarp annual, solitary to caespitose, central, eccentric to sublaterally stipitate. **Pileus** infundibuliform, semicircular to irregularly circular, finally festooned-lobed, 35-120 mm in diam., 20-80 mm high, 1-4 mm thick, coriaceous to woody when fresh, breakable to rigid when dry. **Pileus surface** glabrous, smooth, wrinkled when dry, dark brown (10YR 3/2 to 7.5YR 3/2) to brown (5YR 3/4). **Margin** smooth to lobed-festooned, involute when dry. **Stipe** cylindric to flattened, slightly broadened basally, 6-50 mm long, 7-13 mm in diam., woody, very rigid and wrinkled when dry, surface velutinous, dark brown (10YR 3/2). **Hymenophore** cream coloured (2.5YR 7/4) to beige (10YR 5/4) or brown (7.5YR 5/6). **Pores** circular to angular when dry, decurrent on stem, 3-7 per mm, tubes 1-2 mm long. **Context** homogeneous, corky to woody, cream coloured to beige, 1.5-3 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin- to slightly thickened walls, 2-6 μm in diam.; skeleto-binding hyphae very thick-walled, lumen visible to solid, 2.5-5 μm in diam. and up to 6 μm in the context, yellowish, much branched, dominating throughout the context and dissepiments. **Stipe cortex** formed by a basal layer composed of appressed hyphae, more or less quadrangular in shape, with sinuous walls, and an external layer of clavate, very thick-walled elements, 20-22 x 5-8 μm , arranged in a loose palisade, its thickness equal to that of the basal layer, masked by a melanoid substance that forms an external band. **Hymenium** formed by clavate, 4-spored basidia, 16-24 x 5.5-8 μm . **Cystidioles** rostrate, 18-32 x 4-6 μm , present among the basidia. **Basidiospores** subcylindric to ellipsoid, thin-walled, hyaline, 6.5-9 x 3-4 μm .

Cultural features: Nobles (1958, 1971); Siepmann (1971); Wright & Deschamps (1972); Deschamps & Wright (1975); Stalpers (1978).

Substrate: on dead wood of *Araucaria araucana*, *Aristotelia maqui*, *Austrocedrus chilensis*, *Maytenus boaria*, *Nothofagus antarctica* and *N. dombeyi*.

Distribution: S Argentina and Chile, Brazil (Amazonas?). Circumpolar in temperate zones, according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — ARGENTINA. CHUBUT: Lago Puelo Nat'l Park, N bank, W piedmont of the Valle de las Lágrimas, 4.V.1998, leg. R. M. Silveira & M. Rajchenberg 360 (BAFC 50767), on *Aristotelia maqui*; ibid., 361, 362, 363, 364, 365, 367 (BAFC 50768, 50769, 50770, 50771, 50772, 50773), on *Nothofagus dombeyi*; Los Alerces Nat'l Park, Río Arrayanes, nr. Park Headq., 5.VI.1999, leg. M. Rajchenberg 11945 (BAFC 50781), on felled trunk in *N. dombeyi* and *A. chilensis* woods; Lago Futalaufquen, path to Lago Krugger, 6.V.1998, leg. R.M. Silveira & M. Rajchenberg 376, 377, 378 (BAFC 50774, 50775, 50776, on fallen *Maytenus boaria*; Lago Rivadavia, camping area, 9.V.1998, leg. R. M. Silveira & M. Rajchenberg 385 (BAFC 50777), on *N. antarctica* ("ñire"). NEUQUÉN: Lago Nahuel-Huapi, Villa La Angostura, 30.IV.1958, leg. C. Pujals & I. Gamundí (BAFC 20382); Nahuel-Huapi Nat'l Park, Villa Tacul, 20.III.1963, leg. I. Gamundí (BAFC 21314), on dead trunk of *Nothofagus* ("coihue"); Lanin Nat'l Park, Tromen, 20.V.1999, leg. M. Rajchenberg 11935 (BAFC 50782),

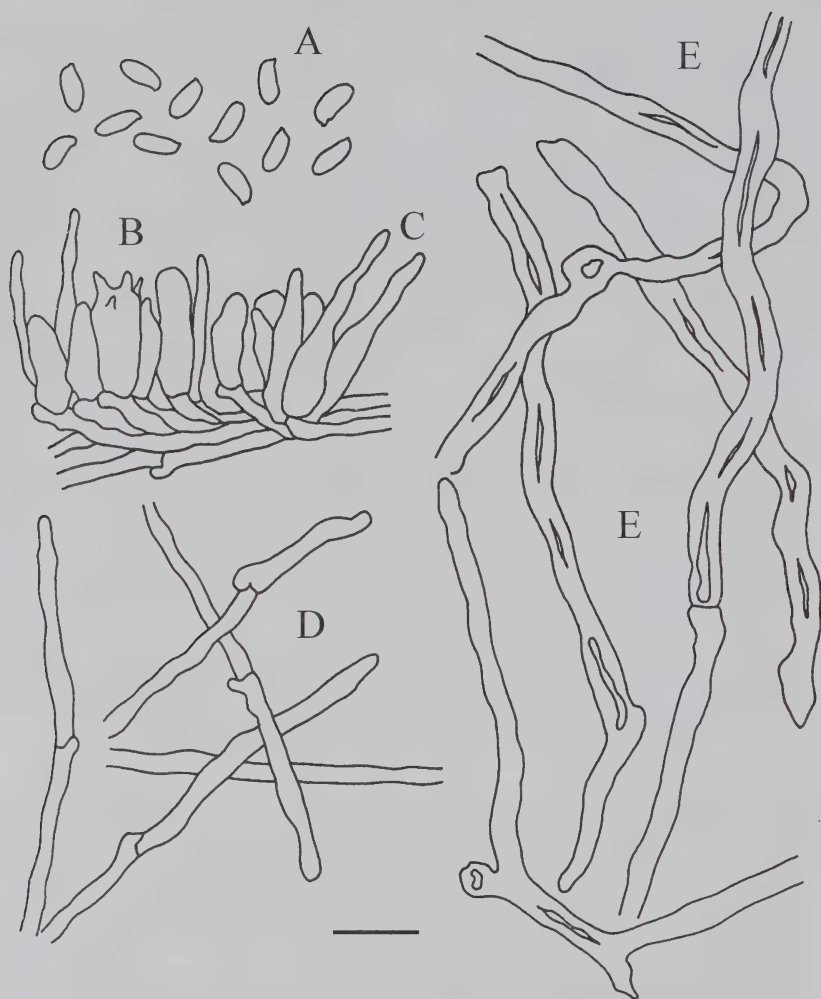


Figure 12: *Polyporus melanopus* (BAFC 50768). A) spores; B) basidia; C) rostrate cystidioles; D) generative hyphae; E) skeleto-binding hyphae. Scale bar = 13 μ m.

on stump of *Araucaria araucana*; Puerto Manzano, 26.IV.1963, leg. Singer M3605 (BAFC 22636); 8.IV.1965, leg. Singer (BAFC 34712); 18.IV.1965, leg. Singer M5039 (BAFC 34711); III.1965, leg. J. Diem 3258 (BAFC 34712, "*in silva nothofaginea-austrocedrina*"; Selva Triste, 21.I.1971, leg. J. E. Wright (BAFC 22448), on dead fallen trunk of *Nothofagus* sp. **RÍO NEGRO:** Bariloche, Mallín Ahogado, Río Azul, 15.V.1998, leg. R. M. Silveira & M. Rajchenberg 386, 387, 388 (BAFC 50778, 50779, 50780); Lago Nahuel-Huapi, Brazo Tristeza, 7.V.1964, leg. Singer M3976 (BAFC 22582); Lago Guglielmo, 20.I.1974, leg. G. Rosso (BAFC 50835); Lago Gutiérrez, 11.V.1978,

leg. J. R. Deschamps (BAFC 50836), on *N. dombeyi*. **TUCUMÁN:** Ciudad Universitaria, 12.I.1959, leg. Singer (BAFC 34713), on dead undetermined trunks. **CHILE:** *Magallanes*; Puerto Natales, P. Antonio Vares, 12.III.1984, leg. Bresinsky & Garrido (BAFC 30728), on trunk of *N. antarctica*; *Talca*: San Clemente, Parque Gil de Vilches, 12.IV.1980, leg. Garrido (BAFC 30729), on rotten trunks of "hualle". **USA. NORTH CAROLINA:** Waynesville (**HOLOTYPE** of *Polyporus fissus* K 57289). Collection data unknown (Presumed **HOLOTYPE** of *P. melanopus* K 82679).

Remarks: According to Núñez & Ryvarden (1995b), *Polyporus melanopus* has large pores (3-4 per mm). All our collections have smaller pores (3-7 per mm) and the holotype of the species has pores 5-8 per mm. Furthermore, the former authors consider *P. fissus* Berk. a synonym of *P. melanopus*. We have also studied the holotype of *P. fissus* and found it has 10-12 pores per mm. Therefore, both holotypes studied are nearer to the pore dimensions of our collections. *Polyporus dictyopus* is very similar morphologically to *P. melanopus*, both species have small pores, differing mainly in the type of substrate and distribution (Silveira & Wright, 2002).

13. *Polyporus philippinensis* Berk., Hooker London J. Bot. 1: 148. 1842.

FIGURE 13 and PLATE 6D

= *Favolus fibrillosus* Lév., Ann. Sci. Nat., sér. III, 2: 201. 1844.- *F. junghuhnii* Lév. Ann. Sci. Nat., sér. III, 2: 202. 1844.

Basidiocarp annual, laterally stipitate. **Pileus** flabelliform to lobate or semiinfundibuliform, 30-95 x 25-80 mm and 2-8 mm thick, coriaceous to rigid when dry. **Pileus surface** glabrous, smooth to radially striate, beige (2.5YR 7/4) to light brown (2.5YR 6/4) when fresh, cream coloured (2.5YR 8/4) to light brown (10YR 7/6 to 5/4) when dry. **Margin** entire or scooped, fertile below or with a sterile band. **Stipe** a disciform pseudostipe or a mere attenuated, eccentric prolongation of the pileus, 3-12 mm in diam., resistant, hard, concolorous with the pileus surface. **Hymenophore** cream coloured (2.5YR 8/4) to beige (10YR 7/6 to 6/6). **Pores** circular to angular, 1-2 per mm when fresh, radially elongated, 1-3 per mm when dry, tubes 2-5 mm long. **Context** homogeneous, waxy to cottony, white to cream coloured, 1-5 mm thick.

Hyphal system dimitic; generative hyphae tenuous, scantily clamped, hyaline, thin-walled, 2-7 μ m in diam.; skeleto-binding hyphae thick-walled to solid, 2.5-11 μ m in diam., pale yellowish, moderately branched, abundant in the dissepiments and context.

Hymenium formed by clavate, 4-spored basidia, 20-30 x 6-7 μ m. **Basidiospores** cylindric to ellipsoid, thin-walled, hyaline, 7-10(-11) x 3-4 μ m. **Cultural features:** Stalpers (1978); De (1977); De & Roy (1981).

Substrate: dead wood of undetermined dicots.

Distribution: NE Argentina, Brazil, Indonesia and Philippines. According to Núñez & Ryvarden (1995b), in tropical and subtropical regions, rare in Africa.

SPECIMENS EXAMINED — **ARGENTINA. MISIONES:** Manuel Belgrano, IFONA, 14.IX.1978, leg. Wright, Del Busto & Cabral (BAFC 25174), on rotten trunk in forest, whitish-cream; Iguazú Nat'l Park, Sendero Macuco, 6.IV.1984, leg. Job & Rajchenberg M3563 (BAFC 30.008); 2.VI.1998, leg. R. M. Silveira & A. Fazio 397, 419 (BAFC 50765, 50766). **BRAZIL. AMAZONAS:** Manaus, Reserva Ducke, 13.V.1977, leg. M. A. Sousa (BAFC 25199), on dry trunk; **RIO GRANDE DO SUL:** Nova Petrópolis, mato



Figure 13: *Polyporus philippinensis* (BAFC 50763). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae (dissepiments); E) skeleto-binding hyphae (context). Scale bar = 13 μm .

dos atiradores, 8.VIII.1997, leg. R. M. Silveira 315 (BAFC 50763); mato do Lenz, leg. R. M. Silveira 316 (BAFC 50764). **PHILIPPINES:** (HOLOTYPUS of *Favolus philippinensis* K 60286). **INDONESIA:** Java, Batam (HOLOTYPUS of *Favolus junghuhnii* PC); Manila (HOLOTYPUS of *F. fibrillosus* PC).

Remarks: *Polyporus philippinensis* has been many times mistaken with *P. tenuiculus*, from which it may be distinguished by the light brown colour of the pileus surface with fine radial striae and its firmer consistency; furthermore the pores are somewhat smaller than in *P. tenuiculus*. In herbarium specimens, these differences are more difficult to observe. Some crossings between *P. philippinensis* and *P. tenuiculus* were negative, confirming that these species are different (Silveira & Wright, 2002).

14. *Polyporus rhizophilus* Pat., Journ. Bot. 8: 219. 1894.

FIGURE 14 and PLATES 3A, 5F

Basidiocarp annual, central to eccentrically stipitate. **Pileus** circular, 13-25 mm diam., and up to 3 mm thick, woody, rigid when dry. **Pileus surface** glabrous, smooth, wrinkled when dry, beige (10YR 6/4) to greyish beige (10YR 7/2). **Margin** entire or slightly lobed, smooth. **Stipe** cylindric, slightly broadened at the base, glabrous, 10-20 mm long and 2-4 mm in diam., woody, rigid when dry, dark brown (10YR 3/3). **Hymenophore** yellowish (10YR 6/6) to beige (10YR 6/4). **Pores** circular to angular when dry, 3-4 per mm, tubes up to 2 mm long. **Context** homogeneous, cottony, white, up to 3 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin- to slightly thickened walls, 2.5-6 μm in diam., very abundant throughout the fruitbody; skeleto-binding hyphae thick-walled, lumen generally visible, sometimes solid, 2.5-5.5 μm diam., hyaline, scantily branched, abundant in all the pileus. **Stipe cortex** formed by a pseudohymenodermis of clavate, thick-walled elements with narrow lumen, forming a single coloured layer 10-15 μm thick.

Hymenium formed by clavate, 4-spored basidia, 17-25 x 5-8 μm . **Basidiospores** cylindric to fusoid or subellipsoid, thin-walled, hyaline, 8-12 x 3.5-4 μm .

Cultural features: unknown.

Substrate: on roots of living grasses, mostly species of the genus *Stipa*.

Distribution: Argentina. The species is rare and known only from fields of S. and Central Europe, Morocco, Central Asia and Central US, according to Núñez & Ryvar den (1995b).

SPECIMENS EXAMINED — ARGENTINA. CORRIENTES: Mburucuyá, Ea. Sta. Teresa, 14.V.1969, leg. Pedersen (BAFC 50940). **CZECHOSLOVAKIA.** BOHEMIA CENTRALIS: Praha-Podbaba, in saxis ad Sedlec, 12.VI.1971, leg. Z. Pouzar (BAFC 50841), at the base of living *Stipa capillata*. **Collection observed in the area: ARGENTINA.** BUENOS AIRES: Villa Gesell, II.1972, leg. J. E. Wright, on culms of living *Stipa* sp. in maritime dunes (material lost).

Remarks: Due to the loss of part of the local material, the description given is based primarily on the Czech collection. It is possible that we are dealing with a species parasitic on grasses and introduced with them, particularly in species of *Stipa* employed for the fixation of dunes.

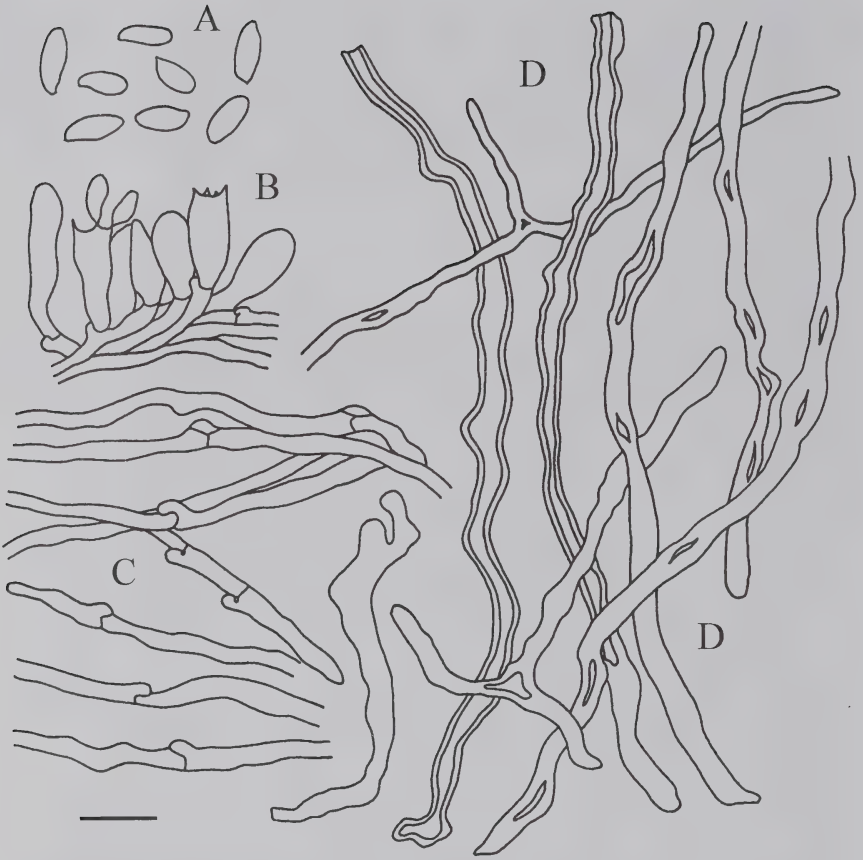


Figure 14: *Polyporus rhizophilus* (BAFC 50841). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μm .

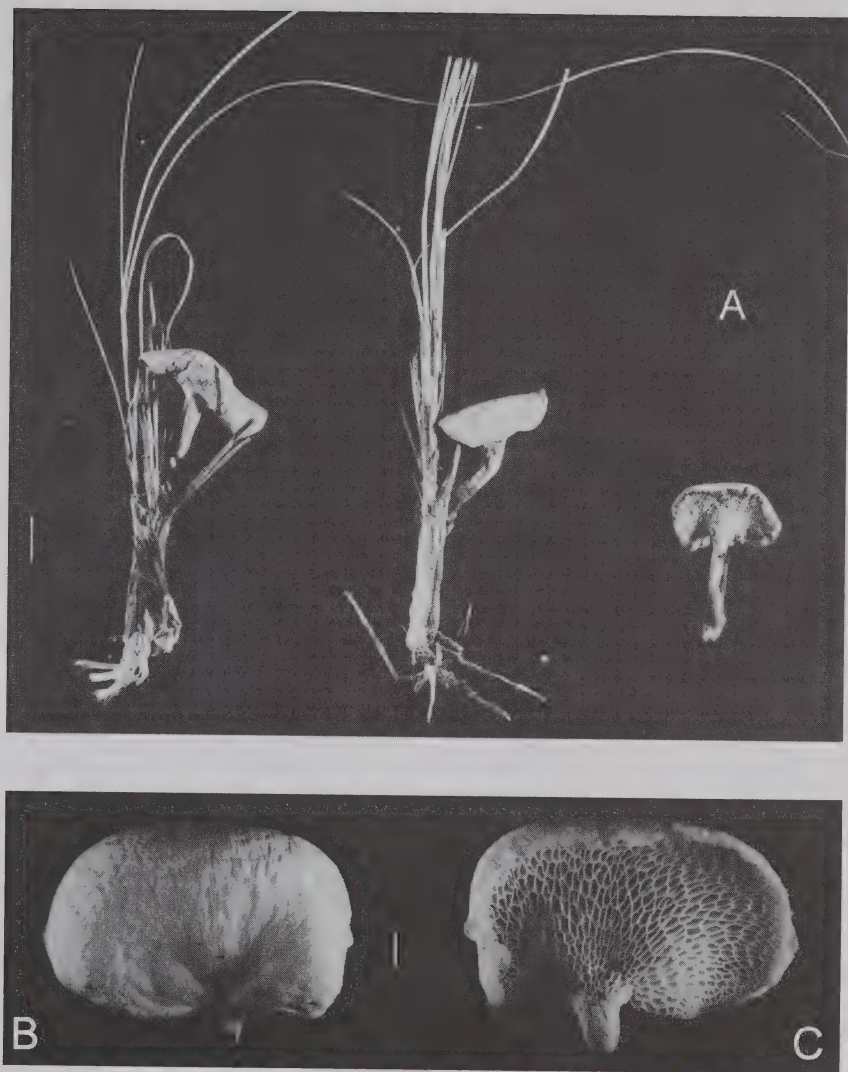


Plate 3. A) *Polyporus rhizophilus* (BAFC 50841). B, C) *P. tenuiculus* (BAFC 50332). Scale bar = 20 mm.

15. *Polyporus saltensis* (Speg.) R.M. Silveira & J.E. Wright, comb. nov.

FIGURE 15 and PLATE 6C

Basionym: *Favolus saltensis* Speg., An. Mus. Nac. Buenos Aires 6: 176. 1898.

Basidiocarp annual, solitary to imbricate, lateral to eccentrically stipitate. **Pileus** flabelliform to almost circular, 15-100 x 20-65 mm and up to 3 mm thick, fleshy when fresh, fragile, breakable and very light when dry. **Pileus surface** glabrous, with fine radial striae, white to yellowish when fresh, beige (10YR 7/6 to 6/6) to brown (10YR 5/8) when dry. **Margin** entire to lobed, smooth, slightly involute when dry, sometimes darker than the pileus surface. **Stipe** cylindric, short or reduced to a disciform pseudostipe, 3-15 mm long and 2-9 mm diam., rigid when dry, surface glabrous, smooth when dry, concolorous with pileus. **Hymenophore** beige (10YR 8/4) to light brown (10YR 6/6) when dry. **Pores** circular to angular, radially elongated, 1.5-3 per mm, tubes up to 1.5 mm long. **Context** homogeneous, cottony, beige, up to 2 mm thick.

Hyphal system dimitic; generative hyphae without clamps, simple septate, hyaline, thin-walled, 3-7 μ m in diam., abundant in all the fruitbody; skeleto-binding hyphae thick-walled, lumen visible to solid, 3-7 μ m in diam., hyaline to pale yellowish, fairly branched, abundant throughout the pileus. **Hymenium** formed by clavate, 4-spored basidia, 20-30 x 5-7 μ m. **Cystidioles** present among the basidia. **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 8-12 x 3-4 μ m.

Cultural features: unknown.

Substrate: dead wood of undetermined dicots.

Distribution: NW Argentina.

SPECIMENS EXAMINED — **ARGENTINA.** TUCUMÁN: Camino del Infiernillo, 22.IV.1966, leg. C. E. Gómez 1032 (BAFC 25193); Tafí del Valle, 7.II.1965, leg. Guerrero & Bettucci (BAFC 50856, 50857, 50858), yellowish-white, on *Piper tucumanensis*; ibid., 7.II.1965, leg. Guerrero & Bettucci (BAFC 50855, 50859, 50860), flabellate, stipe short, yellow; 25.I.1965, leg. Bettucci & Guerrero (BAFC 31187); Salta: La Viña, I.1897, leg. C. Spegazzini (**HOLOTYPUS** of *Favolus saltensis* LPS 21549).

Remarks: Núñez & Ryvarden (1995b) consider *Polyporus saltensis* a synonym of *P. tenuiculus*; however, it can easily be distinguished from it, which it closely resembles, by the absence of clamps, as well as by the smaller pores and the pileus surface, which may have fine radial striae. Núñez & Ryvarden (*op. cit.*) mention that *P. tenuiculus* may or may not have clamps, feature which we have not observed in our materials. The present species seems restricted to the region of the Yungas. Rajchenberg & Wright (1987) considered it was a good name for the species of *Favolus* with simple septa.

16. *Polyporus tenuiculus* (P. Beauv. : Fr.) Fr., Syst. Mycol. 1: 344. 1821.

FIGURE 16 and PLATE 3B, 3C

= *Favolus tenuiculus* P. Beauv., Fl. Oware Benin Afriq. 1: 74. 1806.- *Daedalea brasiliensis* Fr., Syst. Mycol. 1: 1821.- *Favolus flaccidus* Fr., Linnaea 5: 511. 1830.- *F. tessellatus* Mont., Ann. Sci. Nat., sér. II, 2: 365. 1843.- *F. fissus* Lév., Ann. Sci. Nat., sér. III, 2: 201. 1844.- *F. peltatus* Lév., Ann. Sci. Nat., sér. III, 2: 203. 1844.- *F. alutaceus* Berk. & Mont., Ann. Sci. Nat., sér. II, 11: 240. 1849.- *F. lacerus* Fr., Nova Acta Soc. Sci. Upsal., ser. 3, 12: 103. 1851.- *F. sundaicus* Fr., Nova Acta Soc. Sci. Upsal., ser. 3 12: 103. 1851.- *F.*

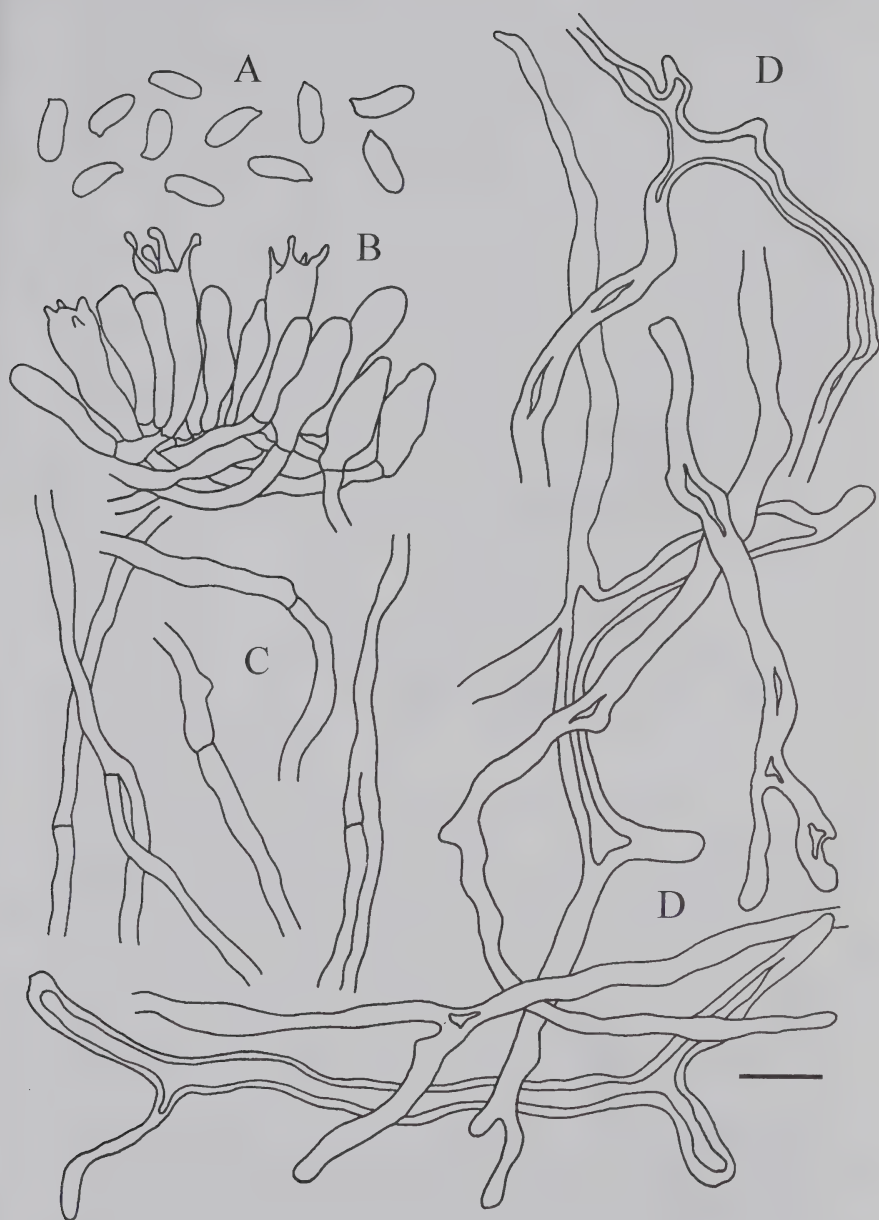


Figure 15: *Polyporus saltensis* (BAFC 50858). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μm .

ohiensis Mont., Syll. Fung. p. 171. 1856.- *F. giganteus* Mont., Ann. Sci. Nat., sér. IV, 5: 370. 1857.- *Hexagonia rhombispora* Mont., Ann. Sci. Nat., sér. IV, 5: 370. 1857.- *F. friesii* Berk. & M.A. Curtis, J.- Linn. Soc. Bot. 10: 321. 1868.- *F. hispidulus* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 321. 1868.- *F. purpurascens* Berk. & M.A. Curtis, J. Linn. Soc. Bot. X, part 1: 321. 1869.- *F. scaber* Berk. & Broome, J. Linn. Soc. Bot. 14: 29. 1873.- *Polyporus lenzitoides* Berk., Vid. Selsk. Kobenhavn Medd. 1879: 34. 1879.- *Favolus paraguayensis* Speg., An. Soc. Cient. Argent. 17: 71. 1884.- *F. speciosus* Speg., An. Soc. Cient. Arg. 17: 71. 1884.- *F. fimbriatus* Speg., An. Soc. Cient. Argent. 17: 72. 1884.- *F. bresadolianus* Speg., Bol. Acad. Nac. Cienc. Córdoba 28: 353. 1926.

Basidiocarp annual, solitary to imbricate, lateral, eccentric or centrally stipitate. **Pileus** flabelliform to circular or infundibuliform, more rarely spatulate, 10-180 x 6-110 mm and 0.5-10 mm thick, fleshy to membranous when fresh, fragile, breakable and very light upon drying. **Pileus surface** glabrous, smooth to radially striate and wrinkled when dry, white to cream coloured (5Y 8/3) when fresh, cream coloured (2.5Y 8/6 to 7/4) to yellowish (10YR 6/6 to 7/8) or beige (10YR 5/8) when dry. **Margin** entire or lobed, smooth or fimbriate, involute and, sometimes, light brown (10YR 5/8) when dry. **Stipe** cylindric, 2-40 mm long and 1-13 mm diam., fibrous when fresh, rigid to fragile when dry, surface glabrous, smooth or wrinkled when dry, concolorous or slightly lighter than the pileus surface. **Hymenophore** white to cream coloured (5Y 7/4) when fresh, beige (10YR 8/6 to 5/6) to yellowish (2.5Y 7/6 to 7/8) or light brown (10YR 4/4) when dry. **Pores** circular to angular, radially elongated, decurrent on the stipe, with entire or fimbriate borders, 0.6-1.5 per mm, tubes 0.5-9 mm long. **Hyphal pegs** sometimes present in the tube walls. **Context** homogeneous, tough cottony to corky, white to cream coloured or beige, 0.3-2 mm thick., sometimes not discernible.

Hyphal system dimitic; generative hyphae clamped, hyaline, with thin- to slightly thickened walls in the stipe and context, 2-6 μm in diam., abundant throughout the fruitbody; skeleto-binding hyphae thick- to very thick-walled, lumen visible to solid, 2.5-5 μm in diam., and up to 9 μm diam. in the stipe, hyaline to yellowish or golden, moderately to much branched, dominating in the context and stipe.

Hymenium formed by clavate, 4-spored basidia, 20-35 x 5-8 μm . **Cystidioles** ampulliform, 20-30 x 6-8 μm and hyphidia sometimes present among the basidia. **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 8-13(-15) x 2.5-4(-5) μm .

Cultural features: Sen (1973, as *Favolus brasiliensis*); Stalpers (1978).

Substrate: dead wood of undetermined dicots and gymnosperms.

Distribution: Argentina, Bolivia, Brazil, Colombia, Cuba, French Guyana, Indonesia, Paraguay, Perú, Trinidad and Venezuela. Pantropical, according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — ARGENTINA. CORRIENTES: Capital, 28.IV.1988, leg. O. Popoff 402; Fac. Cs. Agrarias, 23.X.1995, leg. O. Popoff 2784; Bella Vista, behind Estac. Exp. INTA, in marginal forest, 14.VIII.1972, leg. Wright, Deschamps & Del Busto Ctes 1831 (BAFC 25167); Concepción, Tabay, in forest of implanted *Grevillea robusta*; 16.IV.1987, leg. A. Schinini 35336 (CTES); Ea. Sta. Teresa, 14.V.1962, leg. Pedersen (BAFC 25168); Isma Meza, S zone, in gallery forest, 12.XII.1992, leg. O. Popoff 1268 (CTES); Riachuelo, 18.X.1996, leg. O. Popoff 3243 (CTES); San Miguel, Ea. Curupayti,

interior of forest island, 3.III.1990, leg. R. Vanni et al. 1752 (CTES); Sto. Tomé, Ea. Garruchos, potrero Puente, 4.II.1972, leg. A. Krapovickas & C. L. Cristóbal 22235 (CTES), forest island. **MISIONES:** road to Bernardo de Irigoyen, leg. Wright, Deschamps & Del Busto M2438 (BAFC 25172); Frontera, Gral Manuel Belgrano, 20.IV.1957, leg. Singer M1143 (BAFC 25190), on wood in subtropical forest of *Araucaria angustifolia*; Garupá, near brook, 16.IV.1976, leg. J. de Cricel (BAFC 25173); Gruta India, route 12, 7.VIII.1977, leg. J. De Cricel (BAFC 25171); Guaraní, track to El Soberbio brook, 30.XI.1994, leg. G. Lvia et al. 45 (CTES); Predio Guaraní, 8.IX.1994, leg. O. Popoff et al. 2459 (CTES); Sendero Arroyo Itapirú, 19.IX.1995, leg. V. Mruak (CTES); pr. H. Irigoyen, camping on Ñacanguazú brook, 25.X.1973, leg. Wright, Deschamps & Del Busto M2329 (BAFC 25170), on felled trunk of undet. broadleaf; Iguazú Nat'l Park, 5.III.1982, leg. J. E. Wright (BAFC 28008); camping El Ñandú, 7.IV.1984, leg. Wright, Rajchenberg & Job M3644 (BAFC 30067); lower circuit of falls, 5.IV.1984, leg. Job & Rajchenberg M3554 (BAFC 30010), in mixed forest of palo rosa and palmetto route 101); 4.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 410, 411 (BAFC 50811, 59357), on *Bastardiopsis densiflora* ("loro blanco"); palmital at intersection of route 101 and entrance to Park, 4.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 414, 415, 416 (BAFC 50812, 50358, 59359); Isla San Martín, 3.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 406, 407, 408, 409 (BAFC 50353, 50354, 50355, 50356); Sendero Macuco, 6.IV. 1998, leg. Job & Rajchenberg M3564 (BAFC 30009); 3.IV.1996, leg. O. Popoff et al. 3181 , 3225 (CTES); 2.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 393, 394, 396, 397, 399 (BAFC 50349, 50813, 50350, 50765, 50352); picada paralela, 8.IV.1984, leg. Wright, Rajchenberg & Job M3661 (BAFC 30081); track to falls, 7.IX. 1996, leg. I. Gazzola (BAFC 34370); 3.VI.1998, leg. R. M. Silveira, A. Fazio & E. Albertó 400, 401, 402 (BAFC 50814, 50815, 50816); forbidden zone , 300 m from boundary, al right of road, 7.IV.1984, leg. Wright, Rajchenberg & Job M3641 (BAFC 30064); Puerto Iguazú, 12.IV.1957, leg. Singer M957 (LIL), on dead liana in subtropical forest; San Ignacio, II.1965, leg. Martínez Crovetto G184 (BAFC 25169), Santa Ana, 18.IX.1979, leg. D. Cabral & S. López M3211 (BAFC 25292); Jesuitic Ruins, 24.X.1973, leg. Wright, Deschamps & Del Busto M2309 (BAFC 25191), on dead trunk of *Enterolobium* ("timbó") in the cemetery. **SALTA:** Sta. Victoria, Los Toldos, El Astillero, 17.III.1986, leg. Palací 440. **BOLIVIA:** leg. Weddell (**HOLOTYPE** of *Hexagonia rhombispora* **PC**); **BENI:** Beni: Vaca Diez, Guayaramerín, 7.III.1956, leg. Singer B1632 (BAFC 25195). **BRAZIL.** (**HOLOTYPE** of *Favolus flaccidus* **UPS**); **AMAZONAS:** Manaus, Reserva Ducke, 18.V.1977, leg. M. A. Sousa, (ex Manaus 248); **BAHIA:** leg. Blanchet (**HOLOTYPE** of *F. alutaceus* **K** 77569). **PARANÁ:** Curitiba, Res. Biol. Cambuí, 4.IV.1980, leg. A. de Meijer 423 (BAFC 31699). **RIO GRANDE DO SUL:** leg. Angelo Schneider (ICN 102683); Canela, Parque das Sequoias, 22.I.1997, leg. R. M. Silveira & R. T. Guerrero 311 (BAFC 50817), on dead branch of gymnosperm; Porto Alegre, Parque Farroupilha, 25.XI.1996, leg. R. M. Silveira & R. T. Guerrero 304 (BAFC 50793)0, on base of banana tree; Salvador do Sul, IX.1997, leg. R. T. Guerrero (ICN 102667); Tenente Portela, Parque do Turvo, 23.XI.1975, leg. M. A. Sousa (BAFC 25179); 24.XI.1975, leg. M. A. Sousa, (BAFC 25180); Viamão, Parque St.-Hilaire, 4.XII. 1996, leg. R. M. Silveira & R. T. Guerrero 306, 307, 308 (BAFC 50818, 50332, 50333); 17.X.19998, leg. R. M. Silveira 422, 424, 425, 434, 438 (BAFC 50819, 50362, 50820, 50821, 50822). **RIO DE JANEIRO:** Rio de Janeiro, III.1836, Voyage de M. Gaudichaud (**HOLOTYPE** of *F. fissus* **PC**); leg. Glaziou (**HOLOTYPE** of *Polyporus lenzitoides* **K** 60284); Corcovado, leg. Zelinek (**HOLOTYPE** of *F. brasiliensis* **UPS**); Floresta da Tijuca, X.1961, leg. Singer 4045 (BAFC 25197). **SANTA CATARINA:** Florianópolis, Saco Grande, UFSC-UCAD, 16.I.1998, leg. R. M. Silveira 352 (BAFC 50823). **CUBA:**



Figure 16: *Polyporus tenuiculus* (BAFC 50356). A) spores; B) basidia and basidioles; C) cystidia ampulliform D) generative hyphae; E) skeleto-binding hyphae. Scale bar = 13 μm .

leg. C. Wright 324 (**HOLOTYPE** of *F. hispidulus* K 77570); 318 (**HOLOTYPE** of *F. purpurascens* K 77605); leg. C. Wright (**HOLOTYPE** of *F. lacerus* K 77595). **FRENCH GUYANA**: leg. Leprieur 958 (**HOLOTYPE** of *F. giganteus* PC); 579 (**HOLOTYPE** of *F. tessellatus* PC). **INDONESIA. JAVA** (**HOLOTYPE** of *F. peltatus* PC); Sundaöarna, Sulo Milo, leg. Diedrichsen (**HOLOTYPE** of *F. sundaicus* UPS). **PARAGUAY**: Caazapá, Sta. Ursula, 37 km N of Yuty, 23.III.1993, leg. O. Popoff et al. 1480 (CTES); Cordillera, Altos, Bernal-Cué, 20.VI.1973, leg. A. Schinini 6762 (CTES), on posts on ground; Guaira, Colonia Independencia, banks of Arroyo Tilinsky, 25.III.1993, leg. O. Popoff et al. 1584 (CTES); Guarapi, 30.V.1883, leg. Balansa 3918 (**HOLOTYPE** of *F. speciosus* LPS 21552); 1880, leg. Balansa 3342 (**HOLOTYPE** of *F. bresadolianus* LPS 21527); Paraguari, V-1883, leg. Balansa 3906 (**HOLOTYPE** of *F. paraguayensis* LPS 21545); VI.1883, leg. Balansa 3907 (**HOLOTYPE** of *F. fimbriatus* LPS 21531); 27.VII.1993, leg. G. Mälme (ex S). **SRI LANKA**: South of island, leg. Thwaites (**HOLOTYPE** of *F. scaber* K 77594).

Remarks: *Polyporus tenuiculus* is a very polymorphic species, which has given rise to the numerous synonyms, as listed. Furthermore, its aspect may change according to ambient conditions, see Silveira & Wright (2002). Rajchenberg & Wright (1987) and Popoff & Wright (1998) supported *Favolus paraguayensis* Speg. and *Favolus bresadolianus* Speg. as a good species. After the holotypes analysis and, considering the great polymorphism of *Polyporus tenuiculus*, we concluded that the morphological differences presented to both taxa do not justify their separation in an autonomous species.

In general, it is easy to identify by the features described, principally by the white to cream colour and fleshy consistency of the fruitbodies, as well as the large hexagonal pores. Our collections are all clamped. *Polyporus saltensis* may be separated by the absence of clamps.

17. *Polyporus tricholoma* Mont., Ann. Sci. Nat., sér. II, 8: 365. 1837.

FIGURE 17

=? *Polyporus similis* Berk., Hooker London J. Bot. 2: 635. 1843.- ? *P. stipitarius* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 305. 1868.

Basidiocarp annual, solitary to caespitose, centrally stipitate. **Pileus** circular, umbilicate to infundibuliform, 7-25 mm in diam. and 1-2 mm thick, coriaceous when fresh, rigid upon drying. **Pileus surface** glabrous, smooth to wrinkled when dry, cream coloured (2.5Y 8/4 to 10YR 8/4), to light brown (10YR 7/6 to 5/6). **Margin** entire, ciliate, cilia filiform, 1-2 mm long. **Stipe** cylindric, somewhat broadened at the base, 8-30 mm long, 1-2 mm in diam., fragile when dry, surface glabrous, smooth to wrinkled when dry, concolorous with pileus surface. **Hymenophore** cream coloured (2.5Y 8/4 to 7/4 or 10YR 8/4). **Pores** circular to angular when dry, 5-9 per mm, tubes up to 1 mm long. **Context** homogeneous, cottony, white to cream coloured, up to 1 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin- to slightly thickened walls, 2.5-5 μ m in diam., inflated in the context, up to 10 μ m in diam. in the stipe, sclerified, arranged parallel to the principal axis; skeleto-binding hyphae thick-walled, lumen visible to solid, 2-5 μ m in diam., pale yellowish, moderately branched, dominating in the context and dissepiments. **Hymenium** formed by clavate, 4-spored

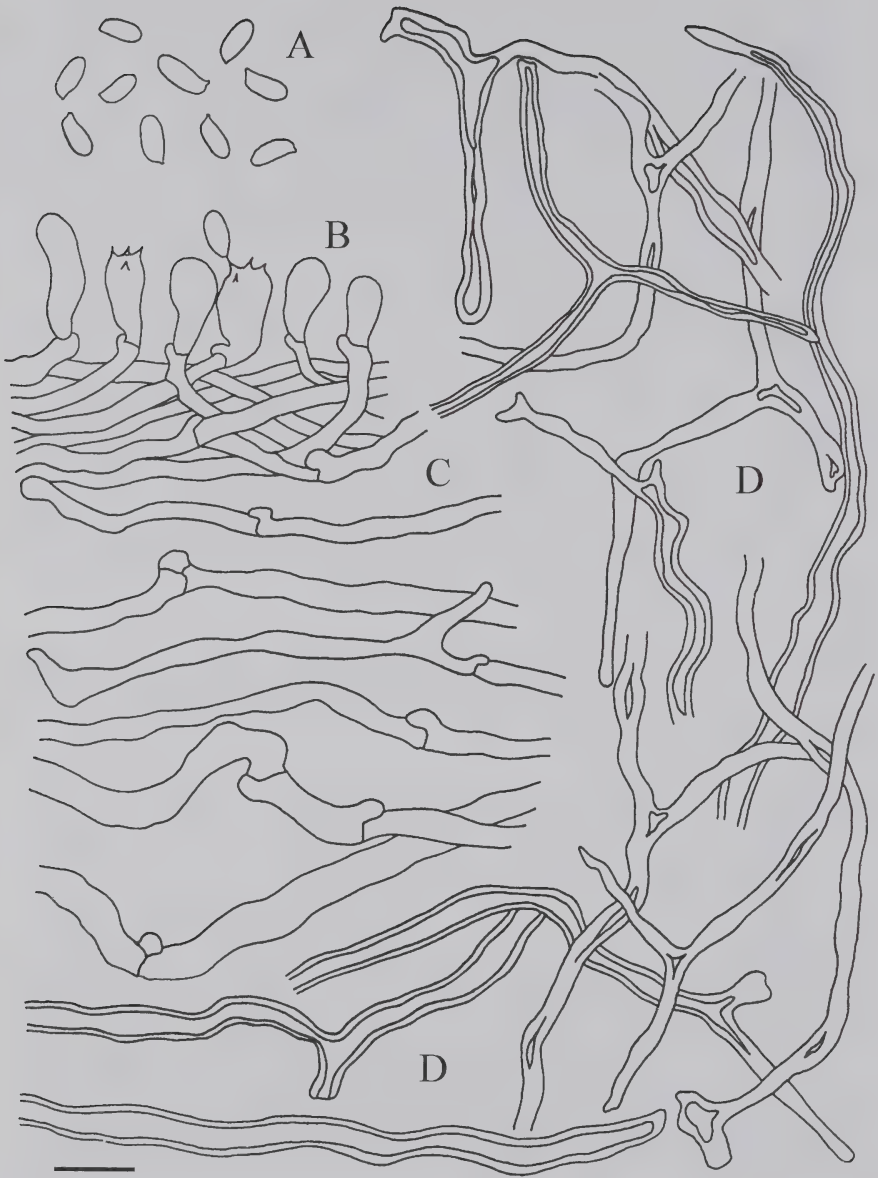


Figure 17: *Polyporus tricholoma* (BAFC 31151). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μm .

basidia, 14-20 x 5-7 μm . **Basidiospores** subcylindric to ellipsoid, thin-walled, hyaline, varying in size in the same basidioma, 6-9 x 3-4 μm .

Cultural features: Roy & De (1977); David and Rajchenberg (1985).

Substrate: dead wood of undetermined dicots.

Distribution: Argentina, Bolivia, Brazil, Cuba, Ecuador, French Guyana, Paraguay, Perú, Trinidad and Venezuela. According to Núñez & Ryvarden (1995b), it is common in the neotropics and very rare in the paleotropics.

SPECIMENS EXAMINED — **ARGENTINA.** CATAMARCA: Cuesta del Totoral, 2.II.1997, leg. D. Cabral (BAFC 34450). MISIONES: Iguazú Nat'l Park, 30 km on route 101, 28.X.1973, leg. Wright, Descamps & Del Busto M2422 (BAFC 50862), on rotten trunk of "laurel negro" in "palo rosa" forest; Puerto Piray, La Celulosa, old *Araucaria angustifolia* plantation (1943), 26.X.1973, leg. Wright, Descamps & Del Busto M2369 (BAFC 50863), on semiroten trunk of *A. angustifolia*. SALTA: C° San Bernardo-C°. 20 de febrero, 14.IV.1987, leg. D. Job 3967, 3987 (BAFC 31149, 31150). TUCUMÁN: route 9, road to El Cadillal, 26.IV.1973, leg. T. del Valle Ruiz (BAFC 50843); Burruyacu, route 310, 3rd. Stop, km 31 from Villa Padre Monti, alt. 1450 masl, mixed woods of *Podocarpus*, *Grabouxia* and *Fragaria*, 1.IV.1998, leg. A. Hladki (LIL); Trancas, La higuera, Ea. Medina, 16.IV.1987, leg. D. Job & A. Hladki 4011, 4013, 4028 (BAFC 31151, 31152, 31153). **BOLIVIA.** LA PAZ: Nor-Yungas, Carmen Pampa, 26.II.1956, leg. Singer B1497 (LIL), 2000 masl. **BRAZIL.** RIO GRANDE DO SUL: Cambará do Sul, Aparados da Serra Nat'l Park, 18.XI.1987, leg. R. M. Silveira & R. T. Guerrero 034, 131, 133, 156 (ICN 80497, 80501, 80502, 80504); Porto Alegre, Belém Novo, XII.1991, leg. M. S. Hamme (ICN 80806). **RIO DE JANEIRO:** Serra dos Órgãos, 24.X.1961, leg. Singer B4030 (BAFC 50864), ca. 1500 masl. **CUBA.** leg. Ramón de la Sagra (**HOLOTYPE** of *Polyporus tricholoma* **PC**); leg. C. Wright 86 (**HOLOTYPE** of *P. similis* **K** 60290); 90 (**HOLOTYPE** of *P. stipitarius* **K** 60291).

Remarks: *Polyporus tricholoma* is also a very polymorphic species of the American tropics. Typical slender, yellowish forms are easy to identify, but larger and more robust ones are not. The study of the holotypes of *P. similis* and *P. stipitarius*, due to their present condition, did not allow a definite conclusion of their synonymy with the present species. An exhaustive study of all of them, on the basis of cultures and DNA would give us a more complete picture of this constellation.

18. *Polyporus tucumanensis* Speg., An. Mus. Nac. Buenos Aires 6: 162. 1898.

FIGURE 18 and PLATE 6B

=? *Favolus apiahynus* Speg., Bol. Acad. Nac. Cienc. Córdoba 23: 407-408. 1919.

Basidiocarp annual, central to eccentrically stipitate. **Pileus** circular, umbilicate, 15-60 mm in diam. when fresh, 10-40 mm in diam. and up to 3 mm thick when dry, fleshy to coriaceous when fresh, hard and breakable upon drying. **Pileus surface** glabrous or with deciduous and scattered squamules, more abundant towards the margin, wrinkled upon drying, brown (10YR 5/4 to 6/4) to light brown (2.5Y 6/4 to 5/4) or cream coloured (10YR 6/6 to 8/3) when fresh, brown (5YR 8/4) to dark brown (7.5YR 3/2) or light brown (7.5YR 6/6), when dry. **Margin** entire or ciliate, incurved



Figure 18: *Polyporus tucumanensis* (BAFC 50340). A) spores; B) basidia and basidioles; C) generative hyphae (dissepiments); D) inflated generative hyphae (context); E) skeleto-binding hyphae. Scale bar = 13 μm .

when dry. **Stipe** cylindric to laterally depressed, 20-70 mm long and 3-5 mm in diam. when fresh, fibrous, glabrous, concolorous or somewhat darker than the pileus surface. **Hymenophore** cream coloured (2.5Y 8/4 to 5Y 7/3) when fresh, ochraceous brown (10YR 5/6 to 7/8) or beige (10YR 8/4) when dry. **Pores** angular, elongated, when young abruptly discontinuous with regards to the stipe, when dry they may appear decurrent on the stem, 3-5 per mm, tubes up to 1 mm long.

Context homogeneous, cottony-stringy, white or cream coloured, up to 1 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin- to slightly thickened walls, 2-5 μm in diam., inflated in the context, up to 23 μm ; sclerified in the stipe, arranged parallel to the principal axis, 5-15 μm in diam.; skeleto-binding hyphae thick-walled, rarely solid, 2.5-6.5 μm in diam., hyaline to pale yellowish, moderately branched, present in the dissepiments. **Hymenium** formed by clavate to subglobose, 4-spored basidia, 16-23 x 5-7.5 μm . **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 6-9 x 2-3 μm .

Cultural features: unknown.

Substrate: dead wood of undetermined dicots.

Distribution: NW Argentina, Brazil?.

SPECIMENS EXAMINED — **ARGENTINA. BUENOS AIRES:** Sta. Catalina, 11.II.1990, leg. E. Albertó & B. Lechner Ed700 (BAFC 50802). **TUCUMÁN:** I.1894, leg. C. Spegazzini (**HOLOTYPE** of *Polyporus tucumanensis* LPS 25777); Chicligasta, Río Cochuna, 14.X.1997, leg. R. M. Silveira & M. Catania 324, 325, 328, 329, 332, 333, 334 (BAFC 50336, 50803, 50339, 50340, 50342, 50343, 50344); *ibid.*, leg. R. M. Silveira & A. Hladki 326, 327, 331, 335, 336, 337, 338 (BAFC 50337, 50338, 50341, 50804, 50345, 50805, 50806); Monteros, Arroyo Las Azucenas, road to Tafi del Valle, 15.X.1997, leg. R. M. Silveira & A. Hladki 322, 323, 342, 343, 344 (BAFC 50334, 50335, 60346, 50347, 50348), in *Alnus jorullensis* forest, 1300 masl. **BRAZIL. SÃO PAULO:** Apiahy, 1883/1888, leg. J. Puiggari 113 and 2916 (**HOLOTYPE** of *Favolus apiahynus* LPS 21521).

Remarks: *Polyporus tucumanensis* has been mistaken for *P. brumalis* by having medium sized pores, and with *P. ciliatus* by having marginal cilia. But it differs from both because its pores are of a different shape from those of *P. brumalis*, and are larger than in *P. ciliatus*. Furthermore, all attempts to mate this species with collections of *P. ciliatus* were negative; see Silveira & Wright (2002). In addition, both species presented significant differences in the isoenzymatic analysis (Silveira et al., 2003). This supports keeping the two species separate. Regarding *P. brumalis*, it is possible that this species is not present in native forests of South America. The distribution of *P. tucumanensis* seems restricted to the region of the Yungas (Cabrera & Willink 1980). For this reason, we consider the synonymy with *F. apiahynus* dubious.

19. *Polyporus udus* Jungh., Tidschr. V. Nat. Gesch. Phys. 7: 289. 1840.

FIGURE 19 and PLATE 6F

=*Polyporus discoideus* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 305. 1868.- *P. paraguayensis* Speg., An. Soc. Cient. Argent. 17: 72. 1883.- *Bresadolia paradoxa* Speg., An. Mus. Nac. Buenos Aires 6: 161.1898.

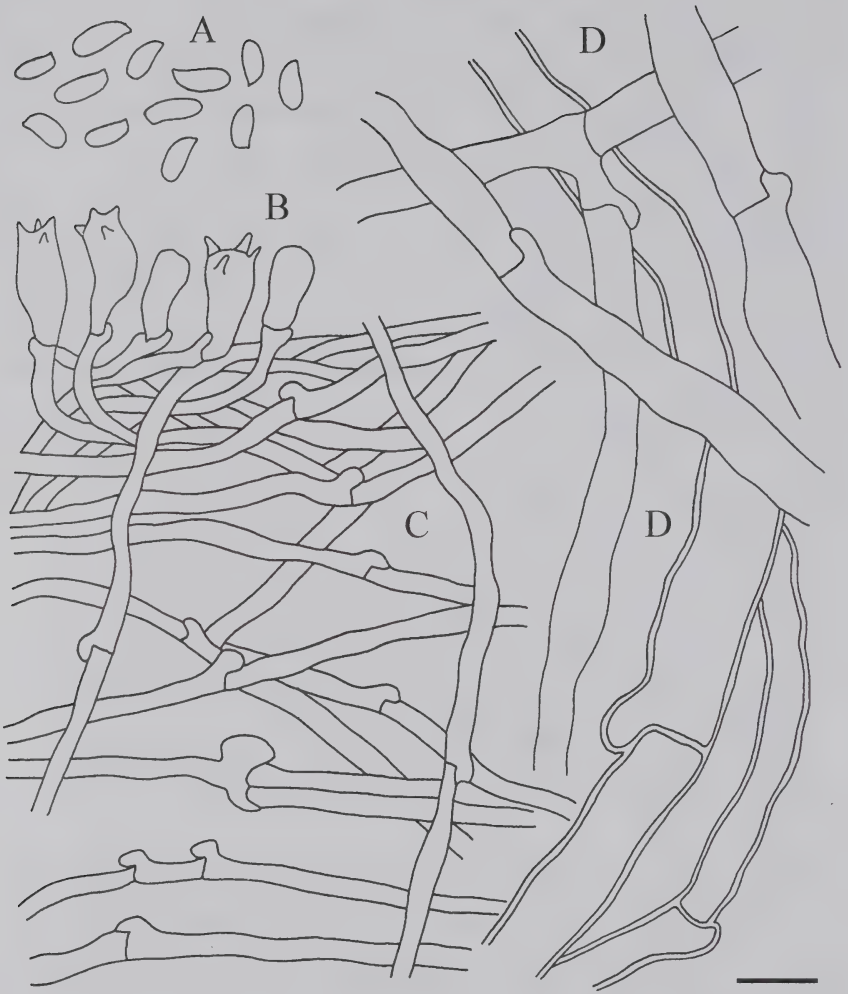


Figure 19: *Polyporus udus* (BAFC 30450). A) spores; B) basidia and basidioles; C) generative hyphae (dissepiments); D) inflated generative hyphae (context). Scale bar = 13 μ m.

Basidiocarp annual, lateral to eccentrically stipitate. **Pileus** semicircular to circular or flabelliform, 30-200 x 50-150 mm, and 5-15 mm thick, fleshy and watery when fresh, fragile and very light when dry. **Pileus surface** glabrous, smooth, wrinkled when dry, brown (7.5YR 5/6 to 4/2) or dark brown (5YR 4/3 to 3/3), with dark brown spots. **Margin** entire, smooth, involute when dry. **Stipe**, when present, cylindric, somewhat broadened at the base, 25-40 mm long, and 9-25 mm in diam., woody and rigid when

dry, surface glabrous, smooth or wrinkled when dry, concolorous with the pileus surface or somewhat darker. **Hymenophore** yellowish orange (7.5YR 7/6 to 5/8) or dark brown (7.5YR 4/4 to 3/2). **Pores** circular to angular when dry, decurrent on the stipe, 1-3 per mm, tubes up to 5 mm long.

[**Context** homogeneous, spongy and watery when fresh, corky when dry, cream coloured to beige, up to 10 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin- to slightly thick-walled, 2.5-5 μm in diam., inflated in the context. up to 15 μm in diam., sclerified in the stipe and pileus cuticle, arranged parallel to the principal axis and coloured by a melanoid substance; skeleto-binding hyphae not observed. **Hymenium** formed by clavate, 4-spored basidia, 20-30 $\times$ 7-10 μm . **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline and of variable size in the same basidioma, 8-10.5 $\times$ 3.5-4.5 μm .

Cultural features: Núñez & Ryvarden (1995a).

Substrate: fallen and semirodden branches of undetermined dicots; sometimes on standing trees.

Distribution: Argentina, Bolivia, Brazil, Cuba, Indonesia, Paraguay and Perú. Pantropical, also known from the warm-temperate zones of Japan, according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — **ARGENTINA.** CHACO: Resistencia, Laguna Cook, 20.XI.1975, leg. J. R. Deschamps (BAFC 50842), on semirodden trunk of *Astronium balansae*. **CORRIENTES:** Saladas, marginal forest of Río Sta. Lucía, 7.II.1972, leg. J. R. Deschamps (ERCIV 5). **MISIONES:** Iguazú Nat'l Park, Sendero Macuco, from Park Headq. to large bridge, 26.IX.1984, leg. D. Job M3825 (BAFC 30410). **BOLIVIA.** **BENI:** Vaca Diez, Ivon, 190 masl, 3.IV.1956, leg. Singer B2448 (BAFC 28874). **BRAZIL.** **PARANÁ:** Foz do Iguaçu, Cataratas do Iguaçu Nat'l Park, 29.XII.1992, leg. A. de Meijer 2384 (Herb. Meijer); São José dos Pinhais, 5.XI.1991, leg. A. de Meijer 2010 (Herb. Meijer). **CUBA:** leg. C. Wright 379 (**HOLOTYPE** of *Polyporus discoideus* K 57288). **PARAGUAY.** Guarapi, XII.1881, leg. Balansa 3364 (**HOLOTYPE** of *P. paraguayensis* LPS 25781); Paraguari, III.1883, leg. Balansa 3913 (**HOLOTYPE** of *Bresadolia paradoxa* LPS 15714). **INDONESIA.** JAVA: Pangarango (**HOLOTYPE** of *Polyporus udus* L).

Remarks: *Polyporus udus* is another polymorphic species which may attain variable sizes, and is characterized by the watery nature of context in fresh specimens, and the pileus surface formed by a thin, dark brown cuticle. It deserves more research.

20. *Polyporus varius* Fr.: Fr., Syst. Mycol. 1: 352. 1821.

FIGURE 20 and PLATE 4A

= *Polyporus guilfoylei* Berk. & Broome, Trans. Linn. Soc. Bot. 2: 58. 1883.

Basidiocarp annual, laterally stipitate. **Pileus** flabelliform to semicircular, or irregularly semicircular, 30-55 $\times$ 25-50 mm and 1-7 mm thick, woody and rigid when dry, punky when fresh. **Pileus surface** glabrous, smooth to finely radially striate, brown (10YR 4/4) to light brown (10YR 5/3) in the region next to stipe, lighter, cream coloured (2.5Y 8/4) to beige (10YR 7/4) towards the margin. **Margin** entire, smooth or undulate, festooned or lobed. **Stipe** cylindric, somewhat broadened at the base, 5-20 mm long



Figure 20: *Polyporus varius* (ICN 80496). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μ m.

and 2-6 mm in diam., woody, rigid when dry, surface glabrous, smooth to wrinkled when dry, black (10YR 2/2). **Hymenophore** beige (10YR 7/6) to grayish beige (2.5Y 6/2) to brown (10YR 5/4). **Pores** circular, 6-9 per mm, tubes up to 3 mm long. **Context** homogeneous, corky, cream coloured to beige, up to 4 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline to pale yellowish, thin-walled, 2-5 μm in diam.; skeleto-binding hyphae very thick-walled, lumen visible to solid, 2.5-7 μm in diam., yellowish to golden, moderately branched, dominating throughout the pileus, variably dextrinoid in the dissepiments. **Stipe** cortex formed by a basal layer composed of more or less quadrangular, appressed cells with sinuous walls, and an external layer of clavate elements, 27-31 x 5-12 μm , thick-walled, arranged in a loose palisade, of about the same thickness as the basal layer, both masked by a melanoid substance forming an external band. **Hymenium** formed by clavate, 4-spored basidia, 15-19 x 6-7 μm . **Basidiospores** subcylindric to ellipsoid, thin-walled, hyaline, 7-9 x 3-3.5 μm

Cultural features: Nobles (1958, 1971); Ingold (1991).

Substrate: dead wood of undetermined dicots.

Distribution: Brazil and Ecuador. See Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — AUSTRALIA: Queensland, Brisbane, Logan River, leg. F. M. Bailey 211 (**HOLOTYPE** of *Polyporus guilfoylei* K 57291). **BRAZIL. RIO GRANDE DO SUL:** Cambará do Sul, Aparados da Serra Nat'l Park, 19.XI.1988, leg. R. M. Silveira & R. T. Guerrero 141 (ICN 80494); leg. *ibid.* 209, 30.IV.1989 (ICN 80495); Gramado, 10.XI-1987, leg. *ibid.* 029 (ICN 80496), on living centenary trunk of *Araucaria angustifolia*; Nonoai, V.1996, leg. R. T. Guerrero (BAFC 50825).

Remarks: *Polyporus varius* is easy to identify by its cream coloured to light brown, smooth to finely radially striate pileus and its black stipe. According to Núñez & Ryvarden (1995b), *P. varius* has spores 9-12 μm long, whereas our collections have shorter ones (7-9 μm). Our materials are coincident with the description of Jahn (1969).

21. *Polyporus virgatus* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 304. 1868.

Figure 21 and Plate 4B

= *Polyporus guaraniticus* Speg., An. Soc. Cient. Argent. 26: 6. 1883.

Basidiocarp annual, laterally stipitate. **Pileus** flabelliform to petaloid, 85 x 55 mm and 3-5 mm thick, breakable when dry. **Pileus surface** glabrous, rugose, yellowish brown (7.5YR 5/6), darker to almost black towards the stipe (7.5YR 3/2). **Margin** entire to festooned-undulate, with very dark lineal spots or markings on a beige background (10YR 6/6). **Stipe** cylindric, sometimes slightly enlarged towards the base, 20 mm long and 8 mm in diam., woody, rigid when dry, surface velutinous, black (10YR 2/2). **Hymenophore** beige (10YR 6/6). **Pores** circular to angular when dry, 2-4 per mm, tubes up to 2 mm long, with the mouths entire to denticulate. **Context** homogeneous, corky, cream coloured, up to 1.5 mm thick.

Hyphal system dimitic; generative hyphae clamped, hyaline, thin-walled, 2-3.5 μm in diam.; skeleto-binding hyphae very thick-walled, lumen visible to solid, 3.5-9(-12) μm diam., pale yellowish, much branched, dominating throughout the context and dissepiments. **Stipe cortex** formed by a basal layer composed of appressed, more or less quadrangular cells with sinuous walls, and an external layer of clavate, thick-walled elements, 21-28 x 5-12 μm , arranged in a loose palisade, of equal thickness

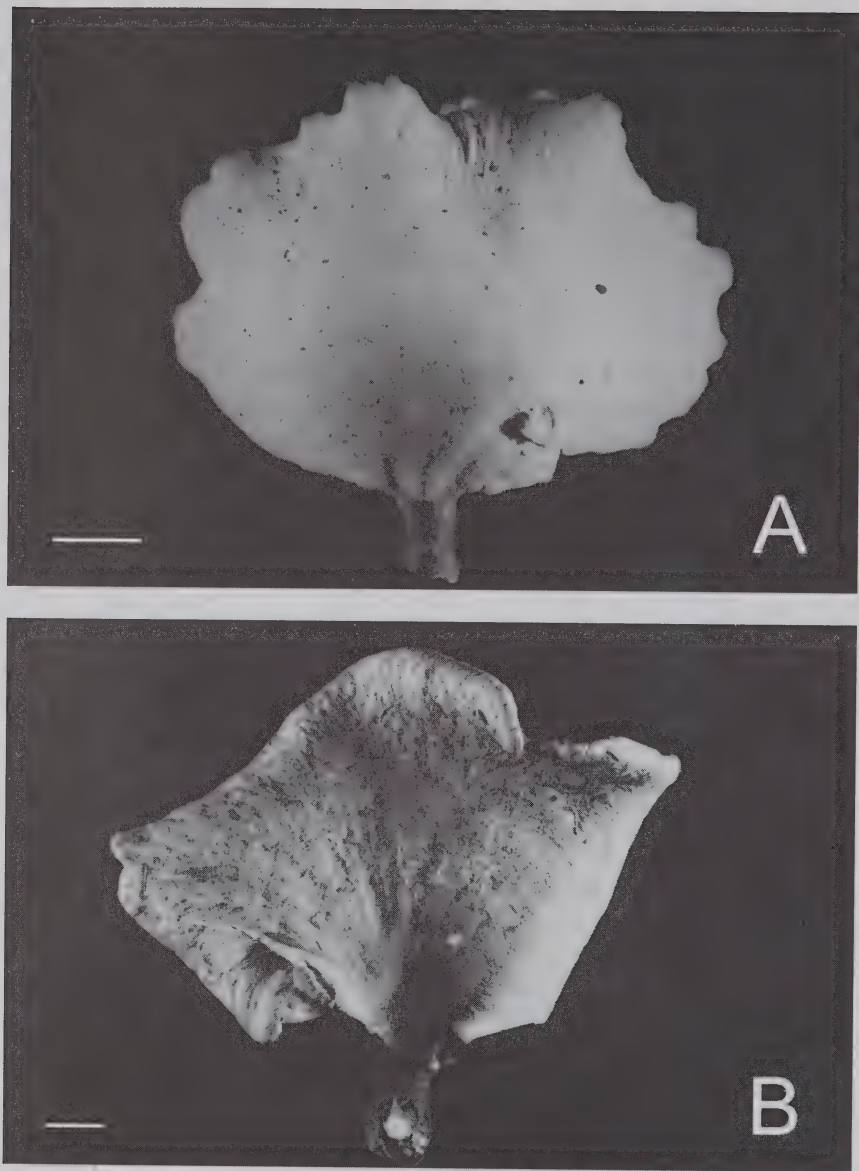


Plate 4. A) *Polyporus varius* (ICN 80496). B) *P. virgatus* (BAFC 31597). Scale bar = 10 mm.



Figure 21: *Polyporus virgatus* (BAFC 31597). A) spores; B) basidia and basidioles; C) generative hyphae; D) skeleto-binding hyphae. Scale bar = 13 μm.

as the basal layer, both masked by a melanoid substance that forms the external band. **Hymenium** formed by clavate, 4-spored basidia, 15-20 x 6-8 μm . **Cystidia** sometimes present among the basidia, and then fusoid, 15-20 x 4.5-6 μm . **Basidiospores** cylindric to subellipsoid, thin-walled, hyaline, 8.5-10.5 x 3-4 μm .

Cultural features: unknown.

Substrate: dead wood of undetermined dicots.

Distribution: Argentina, Brazil, Cuba, Paraguay and Venezuela. Pantropical to subtropical, but not very abundant, according to Núñez & Ryvarden (1995b).

SPECIMENS EXAMINED — **ARGENTINA:** San Lorenzo, 10.VII.1988 (BAFC 31597). **CUBA:** leg. C. Wright 94 (**HOLOTYPE** of *Polyporus virgatus* K 60295).

PARAGUAY: Villa Rica, Sta. Bárbara, I.1882, leg. Balansa 3365 (**HOLOTYPE** of *P. guaraniticus* LPS 25783).

Remarks: *Polyporus virgatus* is easy to recognize by its rather large, flabelliform to petaloid, yellowish brown pileus with dark lineal marking on the margin, and black stipe. It is a relatively rare species in the area under study.

Excluded names

Polyporus anisoporus Delastre & Mont., Ann. Mag. Nat. Hist. 3, 4: 357. 1845.

The specimen is in poor condition.

Polyporus columbiensis Berk., Hooker London J. Bot. 1: 454. 1842.

The specimen is sterile.

Polyporus lentus Berk., In Smith, Engl. Flora 5: 134. 1836.

The specimen is in poor condition.

Polyporus luridus Berk. & M.A. Curtis, Grevillea 1: 37. 1872.

The specimen is sterile.

Polyporus gramocephalus Berk., Hooker London J. Bot. 1: 148. 1842.

Ryvarden & Meijer (2002: Studies in neotropical polypores 14: New species from the state of Paraná, Brazil) include *Polyporus gramocephalus*. Our analyses of Paraná state collections do not include this species. *Polyporus gramocephalus*, which is morphologically close to *P. philippinensis* Berk., differs primarily in pore size. Pore sizes of the holotypes are 4-5 per mm for *P. gramocephalus* and 1-2 per mm for *P. philippinensis*.

Polyporus maculatissimus Lloyd, Mycol. Notes 66: 1113. 1922.

= *Neolentiporus maculatissimus* (Lloyd) Rajchenb.

See Rajchenberg (1995).

Polyporus repando-lobatus Speg., An. Soc. Cient. Argent. 26: 7. 1888.

The specimen is covered with secondary moulds and indeterminable.

Polyporus tuba Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10(45): 305. 1868.

= *Microporellus obovatus* (Jung.) Ryvarden. A very badly developed specimen.

See Ryvarden (1984).

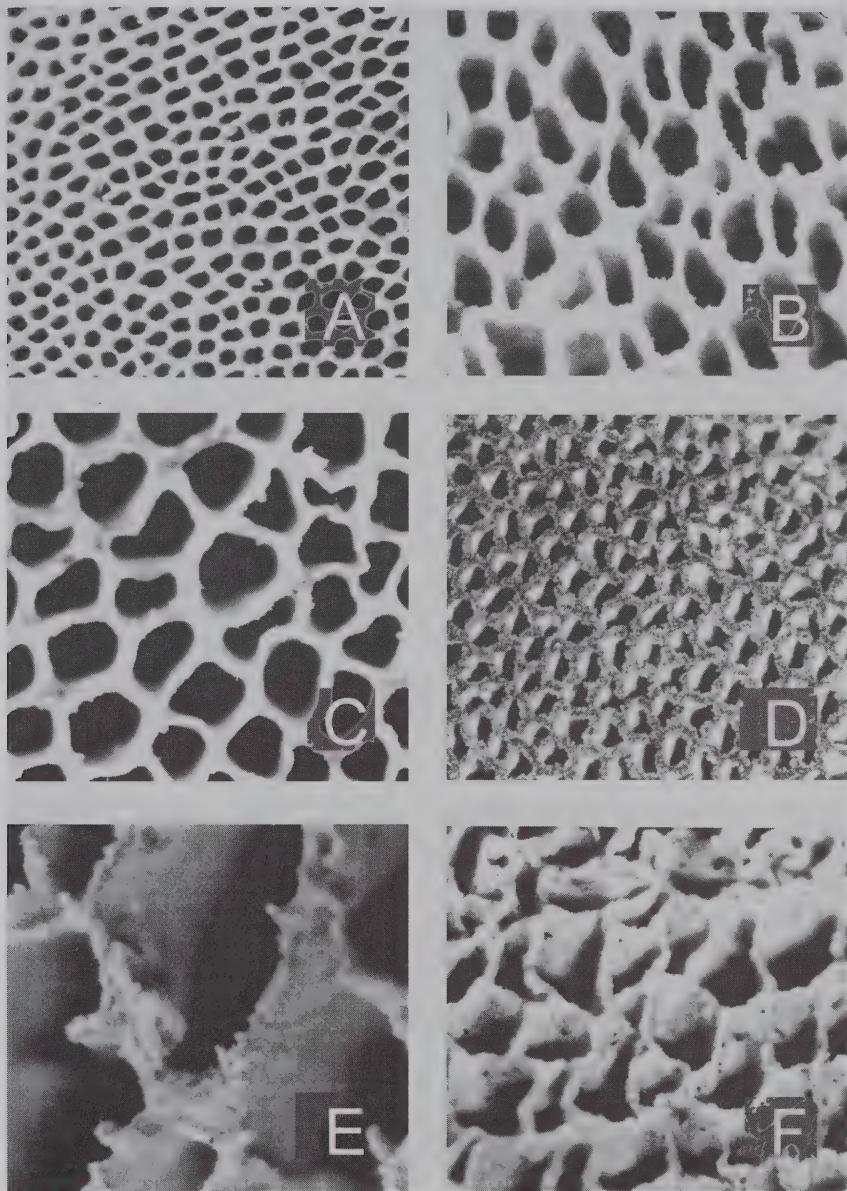


Plate 5. Pore surfaces. A) *Polyporus dictyopus* (BAFC 50787). B) *P. melanopus* (BAFC 50781). C) *P. gyanus* (BAFC 50755). D) *P. leprieurii* (Furtado - ex SP). E) *P. curtipes* (BAFC 25176). F) *P. rhizophilus* (BAFC 50841). All observations under 50 x magnification.

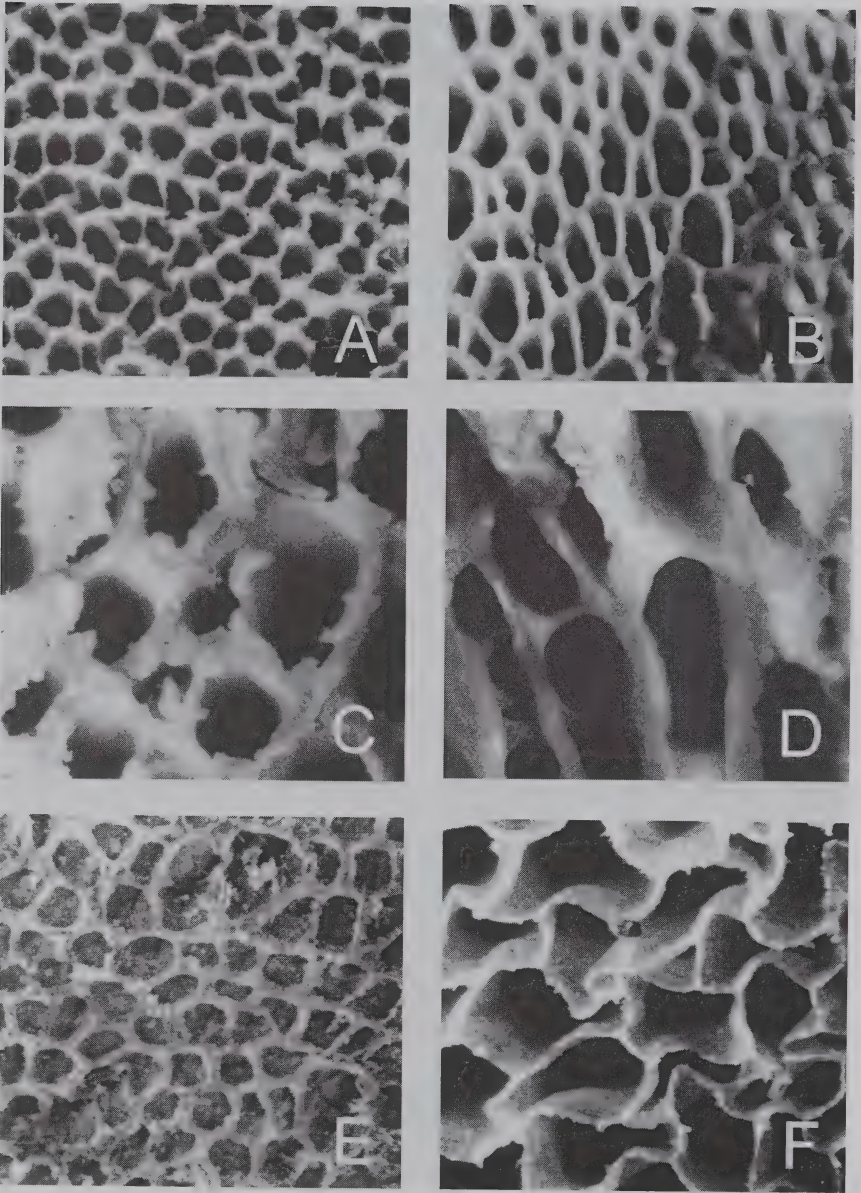


Plate 6. Pore surfaces. A) *Polyporus ciliatus* (BAFC 50369). B) *P. tucumanensis* (BAFC 50339). C) *P. saltensis* (BAFC 31187). D) *P. phillipinensis* (BAFC 50766). E) *P. cyathiformis* (BAFC 30586). F) *P. udus* (A. de Meijer 2010). All observations under 50 x magnification.

Conclusions

We concluded, as did Núñez & Ryvarden (1995b), that *Echinochaete* is an autonomous genus due to the presence of setae on the pileus. A similar criterion has been applied by most authors for the separation of other genera of polypores. Only one species, *E. brachypora*, was found in the area under study.

The four established subgenera: *Polyporus*, *Melanopus*, *Polyporellus*, and *Favolus* are accepted and a new subgenus, *Austropolyporus*, is proposed to accommodate *Polyporus gayanus*.

From this study we concluded that *Pseudofavolus* should not be considered an independent genus, but a synonym of *Polyporus s.str.*, and their species are included here within the subgenus *Favolus*.

Polyporus arcularioides (David & Rajchenberg, 1985) is accepted as an autonomous taxon.

Polyporus brumalis does not appear so far to have been found in the area under study.

Polyporus saltensis is considered an autonomous taxon, different from *P. tenuiculus*, on the basis of the lack of clamps and its apparent restricted distribution to the zone of the Yungas.

Polyporus tucumanensis is considered an autonomous taxon, different from *P. ciliatus*, due to its distribution apparently restricted to the Yungas and the larger pores.

Polyporus guianensis var. *puttemansii* is proposed as a new combination.

Twenty species of *Polyporus s. str.* were identified from the area under study, on the basis of the study of 350 collections and 88 holotypes.

Acknowledgements

We wish to thank very especially the Curators of UPS, L, K, LPS and PC for the loan of valuable holotypes of species of *Polyporus*. The herbaria SP, BAFC, CTES, LIL, ICN and NYS, made available specimens in their keeping, which we gratefully acknowledge. Several colleagues assisted us in different ways, and we wish to state here our gratitude to Dr. Mario Rajchenberg, for cooperating in field trips to the Southern Andean Cordillera Nat'l Parks undertaken by the first author, as well as reading the MS and making invaluable suggestions. We also thank Dra. Rosa T. Guerrero (UFRGS) for collaborating with *Polyporus* collections from Rio Grande do Sul, Brazil. Several colleagues from the Dept. of Biological Sciences, University of Buenos Aires, cooperated in one way or another in the fulfillment of this work. Among them, we wish to thank Dr. Edgardo Albertó, Dr. Bernardo E. Lechner, Dra. Andrea I. Romero for their invaluable collaboration, Lic. Suzana Nietiedt, for line drawings and Vagner Gularte Cortez provided expert technical assistance in the drawings and photographs. Dr. John David (CMI) provided important information concerning the status of the order *Polyporales*. This is paper n° 147 of the PRHIDEB-CONICET. We are grateful to Doctors James Ginns and Mario Rajchenberg for critically revising the manuscript.

Literature Cited

Bakshi BK, Sehgal HS. & Singh B. 1969. Cultural diagnosis of Indian Polyporaceae. I. Genus *Polyporus*. Indian For. Rec. (s.n.) 2(9): 205-244. 13pl.

- Bernicchia AR. 1990. *Polyporaceae* s.l. in Italia. Istituto di Patologia Vegetale, Università degli Studi, Bologna, Italia. 594 pp.
- Cabrera AL. & Willink A. 1980. Biogeografía de América Latina. 122 p. OEA, Washington.
- Corner EJH. 1984. Ad Polyporaceas III. Beih. Nov. Hedw. 78: 1-225.
- David A. & Rajchenberg M. 1985. Pore fungi from French Antilles and Guyana. Mycotaxon 22(2):285-325.
- David A. & Romagnesi H. 1972. Contribution à l'étude de Leucosporos francaises. Description d'une espèce nouvelle. *L. meridionalis* nov. sp. Bull. Soc. Myc. Fr. 88: 293-303.
- De AB. 1977. Interfertility study of *P. gramocephalus* Berk. Curr. Sci. 46:58-59.
- De AB. & Roy A. 1981. Studies on Indian Polypores IV. Morphological and cultural characters of *P. gramocephalus*. Mycologia 73:150-156.
- Deschamps JR. & Wright JE. 1975. Clave para el reconocimiento en cultivo de las especies xilófagas de *Basidiomycetes argentinae*. Rev. Inv. Agrop. INTA Ser. 5, 12: 77-87.
- Donk MA. 1960. The generic names proposed for *Polyporaceae*. Persoonia 1:196-265.
- Gibbertoni TB, Ryvarden L. & Cavalcanti MAQ. 2004. Studies in neotropical polypores 18. New species from Brazil. Synopsis Fungorum 18: 44-56.
- Holmgren PK. & Holmgren NH. 1992. Plant Specialist Index, Index to specialists in the systematics of Plants and Fungi based on data from index Herbariorum (Herbaria). Edition 8. Koeltz Scientific Books.
- Ingold CT. 1991. Conidia of *Polyporus varius*. Mycol. Res. 95:246-247.
- Jahn H. 1969. Die gattung *Polyporus* s. str. in Mitteleuropa. Schweiz. Ztschr. f. Pilzk. 47: 218-227.
- Kreisel H. 1960. Die systematische Stellung der Gattung *Polyporus*. Zeitschr. f. Pilzk. 26: 44-47.
- Léveillé JH. 1844. Champignons exotiques. Ann. Sci. Nat. (Paris) 3, Sér. 1: 167-221.
- Lloyd CG. 1910. Synopsis of the sections *Microporus*, *Tabacinus* and *Funales* of the genus *Polystictus*. Cincinnati, Ohio. 208pp.
- Matters C, da Costa E. & Tamblin N. 1952. The identification of Basidiomycetes fungi in cultural morphological characters of 14 cultures of Basidiomycetes sub-project p.11-12. Progress Report 2:1-33, 19pl.
- Montagne, JFC. 1842. Centurie de plantes cellulaires exotiques nouvelles. Ann. Sci. Nat., Sér. 2, 18:241-282.
- Munsell, Soil Color Charts. 1954. Munsell Color Co., Inc. Baltimore, Maryland, U. S. A.
- Murrill WA. 1904. The *Polyporaceae* of North America. VI. The genus *Polyporus*. Bull. Torr. Bot. Club 31:29-44.
- Nakasone KK. & Gilbertson RL. 1978. Cultural and other studies of fungi that decay ocotillo in Arizona. Mycologia 70:266-299.
- Niemelä T. & Kotiranta H. 1991. Polypore survey of Finland 5. The genus *Polyporus*. Karstenia 31:55-68.
- Nobles MK. 1948. Studies in forest pathology. VI. Identification of cultures of wood-rotting fungi. Can. J. Res. C, 26:281-431.
- Nobles MK. 1958. Cultural characters as a guide to the taxonomy and phylogeny of the *Polyporaceae*. Can. J. Bot. 36:883-926.
- Nobles MK. 1965. Identification of cultures of wood-inhabiting Hymenomycetes. Can. J. Bot. 43:1097-1139.
- Nobles MK. 1971. Cultural characters as a guide to the taxonomy of the *Polyporaceae*. In: Petersen, R.H. (ed). Evolution in the Higher Basidiomycetes. pp. 169-196.

- Núñez M. & Ryvarden L. 1995a. New polypores to Japan 1. The genus *Polyporus*, with a note on *P. hartmannii*. *Mycoscience* 36 (1): 61-65.
- Núñez M. & Ryvarden L. 1995b. *Polyporus* (Basidiomycotina) and related genera. *Fungiflora*. Oslo. 85 pp.
- Patouillard NT. 1887. Les hyménomycètes d'Europe. Anatomie generale et classification des champignons superieurs. 11:1-166. Paris.
- Popoff OF. & Wright J.E. 1998. Fungi of Paraguay. I. Preliminary checklist of wood-inhabiting polypores (*Aphyllphorales*, Basidiomycota). *Mycotaxon* 67:323-340.
- Quélet L. 1886. *Enchiridion fungorum in Europa media et presertim in Gallia vigentium*. Lutetiae.
- Rajchenberg M. 1995. A taxonomic study of the Subantarctic *Piptoporus* (*Polyporaceae*, Basidiomycetes). II. *Nord. J. Bot.* 15:105-119.
- Rajchenberg M. & Greslebin A. 1995. Cultural characters, compatibility tests and taxonomic remarks of selected polypores of the Patagonian Andes forests of Argentina *Mycotaxon* 56:325-346.
- Rajchenberg M. & Wright J.E. 1987. Type studies of *Corticaceae* and *Polyporaceae* (*Aphyllphorales*) described by C. Spegazzini. *Mycologia* 79(2):246-264.
- Reid DA. 1963. New or interesting records of Australasian Basidiomycetes. *Kew Bull.* 17: 196-295.
- Roy A. & De AB. 1977. A record of *P. tricholoma* Mont. from India. *Trans. Br. Myc. Soc.* 68:441-444.
- Ryvarden L. 1984. Type studies in the *polyporaceae* 16. Species described by J. M. Berkeley, either alone or with other mycologists from 1856 to 1886. *Mycotaxon* 20(2):329-363.
- Ryvarden L. 1991. Genera of polypores. Nomenclature and taxonomy. *Fungiflora*. Oslo. 363pp.
- Ryvarden L. & Gilbertson RL. 1994. European polypores 2:388-763. *Fungiflora*. Oslo.
- Ryvarden L. & Iturriaga T. 2004. 9: Studies in neotropical polypores 21. New and interesting species from Venezuela. *Synopsis Fungorum* 18:68-75.
- Ryvarden L. & Meijer A. 2002. Studies in neotropical polypores 14. New species from the state of Paraná, Brazil. *Synopsis Fungorum* 15:34-69.
- Sen M. 1973. Cultural diagnosis of Indian *Polyporaceae*. 3. Genera *Daedalea*, *Favolus*, *Ganoderma*, *Hexagona*, *Irpex*, *Lenzites*, *Merulius* and *Poria*. *Indian Forest Records* (n.s.) 2(11): 277-304, 11 pl.
- Siepmann P. 1971. Art diagnose einiger holzerstörender Hymenomyceten an Hand von Reinkulturen IV. *Nova Hedwigia* 21 (1/4):843-875.
- Singer R. 1986. *The Agaricales in Modern Taxonomy*. 4th Ed. Koeltz Scientific Books. Koenigstein. 981 pp.
- Silveira RMB. da & Wright J.E. 2002. *Polyporus s. str.* in southern South America: mating tests. *Micol. Res.* 106 (11): 1323-1330.
- Silveira RMB. da, Saidman BO. & Wright J.E. 2003. *Polyporus s. str.* in southern South America: isoenzyme analysis. *Micol. Res.* 107 (5): 597-608.
- Stalpers JA. 1978. Identification of wood-inhabiting *Aphyllphorales* in pure culture. *Stud. Mycol.* 16:1-248.
- Wright J.E. 1948. Estudios sobre Basidiomycetes. I *Favolus squamiger* Berk. en la Argentina. *Inst. San. Veg., Minist. Agric. Argentina*, IV, ser. A, n°. 44:1-16.
- Wright J.E. & Deschamps JR. 1972. Basidiomicetos xilófagos de los Bosques Andinopatagónicos. *Rev. Invest. Agrop. INTA Ser.* 5, 9:111-197.

Type studies of some *Ganoderma* species from ChinaD.-M. WANG^{1,2}, X.-Q. ZHANG¹ & Y.-J. YAO^{1*}

yaoyj@sun.im.ac.cn

¹Systematic Mycology and Lichenology Laboratory, Institute of Microbiology
Chinese Academy of Sciences, Beijing, 100080, China² Graduate School of the Chinese Academy of Sciences

Abstract—Results from the study of the types of *Ganoderma microsporum* and *G. formosanum* reveal that they are synonyms of *G. weberianum* and *G. sinense* respectively. The description of *G. shangsiense* is extended to cover a wider range of basidiospore size based on study of the type and other collections. Full descriptions of *G. weberianum* and *G. sinense* are also provided and the nomenclature of a recently proposed new species, *G. guangxiicum*, is discussed.

Key words—*Ganodermataceae*, *Polyporales*, revision, synonym, taxonomy

中文摘要

小孢灵芝 (*Ganoderma microsporum*) 和台湾灵芝 (*G. formosanum*) 模式标本研究的结果显示它们分别是韦伯灵芝 (*G. weberianum*) 和紫芝 (*G. sinense*) 的同物异名。基于模式和其他标本的研究, 上思灵芝 (*G. shangsiense*) 的描述得到了扩展, 以包括更大的孢子尺寸范围。本文也提供了韦伯灵芝和紫芝的全面描述, 并就最近报道的广西灵芝 (*G. guangxiicum*) 新种的命名法问题进行了讨论。

Introduction

Species of *Ganoderma* P. Karst. have been recorded as 'Chi Zhi', 'Ling Zhi', 'Ling Chi', 'Ling Chih', 'Ling Qi', 'Reishi', 'Zi Zhi', '10,000 year mushroom', 'Herb of spiritual potency' and 'Mushroom of Immortality' in the Chinese literature for thousands of years, but the modern taxonomy of *Ganoderma* only began early last century in China. With the efforts of many researchers, especially Teng (1934, 1939, 1963) and Zhao and his colleagues (Zhao et al. 1981, Zhao 1989), a large number of species in the genus have been found in China. In total, 76 species are recognized in the Chinese mycota of *Ganoderma* (Zhao & Zhang 2000), including 37 new species described from this country. Nine new species reported from China were excluded by Zhao & Zhang (2000), because the type material was not available for study. Among the new species accepted by Zhao & Zhang (2000), 18 were described from Hainan, four from Yunnan, three from Guangxi and Taiwan respectively, two from Fujian, and one from

*Author for correspondence

Beijing, Guangdong, Guizhou, Jiangxi, Shandong, Sichuan and Xizang successively. However, nearly 60% of these new species were published based on a single collection. In a recently published illustration of *Ganodermataceae* in China, Wu & Dai (2005) included 77 *Ganoderma* species reinstalling two of the species previously excluded by Zhao & Zhang (2000), and proposing a new species and a new Chinese record.

In an investigation of molecular systematics of *Ganoderma* species reported from China, morphological studies of specimens were carried out to ensure the correct material for molecular work. A revision of type material of three species is presented here with re-determination of some of the collections involved and an extension of the morphological description of the species. Comments on nomenclature of the new species recently proposed in Wu & Dai (2005) are also provided.

Materials and Methods

Specimens observed in this study were mainly herbarium collections from China. A strain named *G. capense* (Lloyd) Teng, housed in the China General Microbiological Culture Collection Center, Beijing, China (CGMCC), numbered as AS 5.71, was cultivated on a substrate containing cottonseed shell, hardwood sawdust, wheat bran and lime. The basidioma was collected as a voucher specimen and deposited in HMAS, with the accession number HMAS 97365.

Cutis sections from the base of pileus were cut by a razorblade. The 5% KOH solution and Melzer's reagent were used as the mounting medium. Optical microscopy studies were carried out at $\times 400$ and $\times 1000$. Size ranges of basidiospores and cuticle cells were based on ocular micrometer measurements. For representative data from each species, at least 20 basidiospores were measured in each specimen. The basidiospore size was given both with and without the myxosporium in the species description, but with the myxosporium in the discussion of species in question. Images of cutis structure and basidiospores were captured with a video system mounted on a Zeiss Axioskop microscope using Differential Interference (DIC) microscopy.

Scanning electron microscopy (SEM) was performed for the surface structure of basidiospores. Samples were taken from hymenophore fragments of herbarium collections and mounted directly on ca. 1.0 cm diam. stubs, using double-sided 'sellotape'. The mounted specimens were coated with gold by a SCD005 Sputter Coater and observed in a FEI QUANTA 200 scanning electron microscope.

Taxonomy

The type collections of *G. formosanum*, *G. microsporum*, *G. shangsiense*, and *G. sinense* were studied. The former two were re-determined as *G. sinense* and *G. weberianum* respectively, and a description of these two types is included under the correct names of the species.

Ganoderma shangsiense J.D. Zhao in Acta Mycol. Sin. 7: 13 (1988). **Figs 1 & 2**

Basidioma annual to perennial, sessile but with a slightly or distinctly contracted base, woody. *Pileus* 6.0–8.5 $\times$ 9.5–13.5 cm, 0.2–5.0 cm thick, reniform, dimidiate

or flabelliform, applanate or convex; upper surface dull, buff, greyish brown to rusty brown, usually covered with a layer of brown basidiospores, with many narrow grooves or not; margin thin or obtuse, concolorous with the pileus or buff. *Pore surface* white to yellowish when young, purplish brown on bruising or at maturity, sometimes vividly yellow near the margin; tubes stratified in old specimens with or without intervening layers of context tissue, up to 2.5 cm long at the base, brown; pores 4–5 per mm, circular, 130–200 μm diam., dissepiments 50–180 μm thick. *Context* up to 5 mm thick, duplex, upper layer yellow or pale buff, lower layer red brown near the tubes, usually with deposits of melanoid substances in two distinct lines; hyphal system trimitic; generative hyphae 3.0–5.0 μm diam., hyaline, thin-walled, with clamp-connexions; skeletal hyphae 5.5–7.0 μm diam., golden brown in 5% KOH solution, dextrinoid in Melzer's reagent; ligative hyphae 1.0–2.5 μm diam., thick-walled. *Basidiospores* 7.5–12.5 (–13.0) $\times$ 6.0–9.0 μm , including myxosporium and 7.5–9.0 $\times$ 5.5–7.5 (–8.0) μm , excluding myxosporium; broadly ovoid to subspherical; brown, with a dark brown eusporium bearing few and thick echinulae, overlaid by a hyaline myxosporium; slightly truncate or not at the apex. *Basidia* not seen. *Cutis* anamixodermic, thin, easily cracked, composed of hyaline hyphae only, dextrinoid in Melzer's reagent.

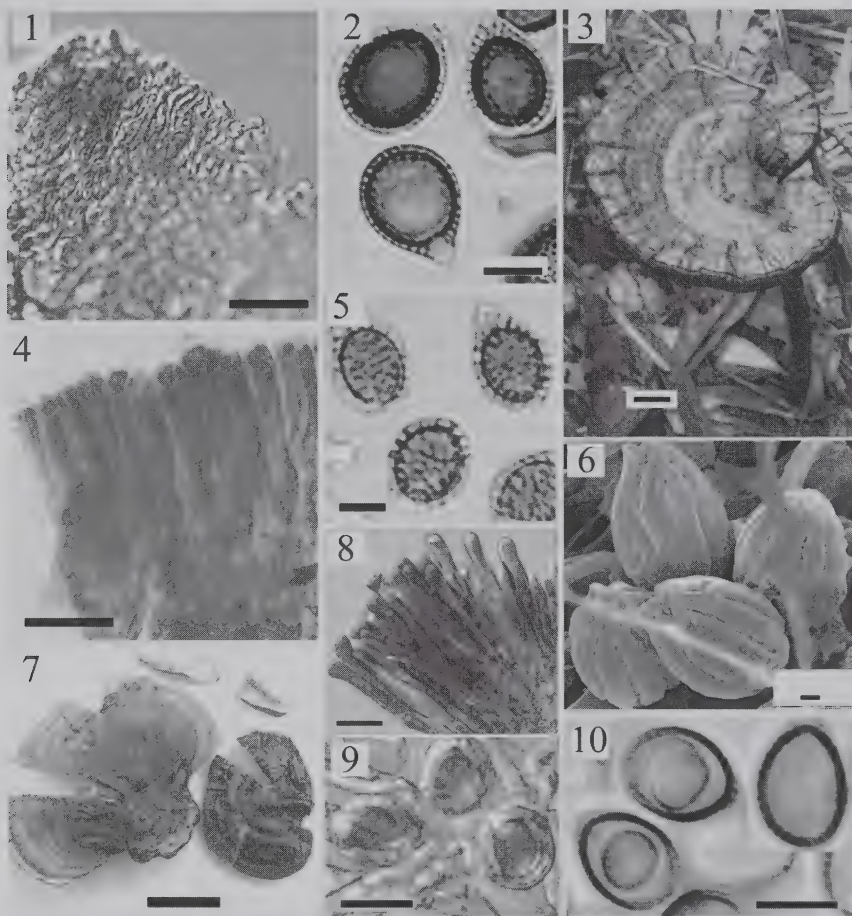
Specimen examined: **China:** **Guangxi**, Shangsì, on rotten wood, 5 Nov. 1958, Z.-C. Liang 1652, HMAS 29741. **Hainan**, Diaoluoshan, on rotten wood, 29 Sept. 1958, J.-H. Yu 325, HMAS 29739 (holotype); Diaoluoshan, on rotten wood, 29 Sept. 1958, J.-H. Yu 147, HMAS 29740; Diaoluoshan, on living tree, 4 Oct. 1958, J.-H. Yu 350, HMAS 29742; Diaoluoshan, on rotten wood of broad-leaved tree, 11 April 1993, J.-P. Lai 1799, HMAS 73477; Diaoluoshan, on dead wood of *Quercus patelliformis* Chun, 13 Dec. 2003, D.-M. Wang 28, HMAS 130043.

Distribution: Guangxi and Hainan provinces, China (Zhao & Zhang 2000, this study).

The above description is based on the listed specimens. This species is characterized by dull upper surface of pileus, duplex context with melanoid substances and broadly ovoid to subspherical basidiospores. The size range of basidiospores was described as 7.5–9.0 (–10.0) $\times$ 6.0–7.5 (–8.5) μm by Zhao (1988) and Zhao & Zhang (2000). Examination of the type material, two basidiomata cut in several pieces, revealed that the basidiospore sizes were different between the two basidiomata, although both of them exhibited typical morphological characters of the species. Basidiospores from one of the basidiomata measured 7.5–9.0 (–10.0) $\times$ 6.0–7.5 (–8.5) μm (with myxosporium, the same in the followings) and 9.0–10.5 $\times$ 8.0–9.0 μm in the other. However, larger basidiospores were also found in the most recent collection cited above, HMAS 130043, reaching 13.0 $\times$ 9.0 μm .

Re-examination of the specimens cited in Zhao & Zhang (2000) also revealed that *G. applanatum* (Pers.) Pat. and *G. adpersum* (Schulzer) Donk were involved in some of them, such as HMAS 19804, HMAS 20729, HMAS 26551, HMAS 39668 and HMAS 47653. All of these specimens have concentrically sulcate upper surface of pileus or duplex context, but the yellow to red brown context, broadly ovoid to subspherical basidiospore distinguish *G. shangsiense* from *G. applanatum* and *G. adpersum*. Further, the basidiospores are ovoid and smaller than 8.5 $\times$ 6.5 μm in *G. applanatum*, and ellipsoid and 8.5–12.5 $\times$ 5.7–7.5 μm in *G. adpersum* (Pegler & Young 1973), compared with those of *G. shangsiense*.

Ganoderma shangsiense has been reported from several provinces of China, i.e. Guangxi, Hainan, Heilongjiang, Sichuan and Xizang (Zhao & Zhang 2000). The distribution of this species in Heilongjiang, Sichuan and Xizang, based on a single misidentified collection, should be excluded. *Ganoderma shangsiense* is a tropical and subtropical species.



Figs 1–10. Photographs of *Ganoderma* spp. Figs 1 & 2. *Ganoderma shangsiense* (HMAS 130043). Fig. 1. Sections of cutis; Fig. 2. Basidiospores. Figs 3–6. *Ganoderma sinense* (Figs 4–6: HMAS 37722, holotype; Fig. 3: HMAS 130316). Fig. 3. Basidioma; Fig. 4. Section of cutis; Fig. 5. Basidiospores under light microscope; Fig. 6. Basidiospores under SEM. Figs 7–10. *Ganoderma weberianum* (Figs. 7–8 & 10: HMAS 57945, isotype; Fig. 9: HMAS 10475). Fig. 7. Basidiomata; Fig. 8. Section of cutis; Fig. 9. Gasterospores; Fig. 10. Basidiospores. Bars = 20 µm in Figs 1, 4 & 8; = 5 µm in Figs 2, 5, 6, 9 & 10; = 1 cm in Figs 3 & 7.

Ganoderma sinense J.D. Zhao, L.W. Xu & K.Q. Zhang in Acta Microbiol. Sin. **19**: 272 (1979). **Figs 3–6**

=*Ganoderma formosanum* T.T. Chang & T. Chen in Trans. Br. Mycol. Soc. **82**: 731 (1984).

Misapplications:

Ganoderma japonicum (Fr.) Lloyd in Teng, Fungi of China: 447 (1963); Tai, Syll. Fung. Sin.: 469 (1979); Teng, Fungi of China: 326 (1996), non *Polyporus japonicus* Fr., Epicrisis: 442 (1838) (= *Ganoderma japonicum* (Fr.) Lloyd, Mycol. Writ. 3: Syn. Stip. Polyp.: 102 (1912)).

Ganoderma lucidum (Leyss.) P. Karst. var. *japonicum* (Fr.) Bres. in Teng in Sinensia **5**: 199 (1934), non *Polyporus japonicus* Fr., Epicrisis: 442 (1838).

Basidoma annual, stipitate, corky-woody. *Pileus* 2.5–6.5 × 5.2–8.0 cm, 0.2–1.2 cm thick in nature, 2.5–6.5 × 3.5–12.0 cm, 0.5–1.5 cm thick when cultivated, dimidiate; upper surface usually purplish black to black, laccate, concentrically sulcate or not, radially rugose; margin often subtruncated. *Pore surface* pale brown to dark brown; tubes up to 1.4 cm long, grey-brown; pores 5–6 per mm, circular, 50–180 µm diam., dissepiments 40–160 µm thick. *Stipe* 6–19 cm long, 0.5–1.0 cm thick, lateral, dorso-lateral or excentric, cylindrical or flattened; concolorous with the pileus, laccate. *Context* 1–5 mm thick, uniformly brown or red brown near the tube layer or with whitish streaks and patches near cutis; hyphal system trimitic; generative hyphae 3.0–5.0 µm diam., hyaline, thin-walled, with clamp-connexions; skeletal hyphae 4.5–7.0 µm diam., golden brown in 5% KOH solution, dextrinoid in Melzer's reagent; ligative hyphae 1.0–2.5 µm diam., thick-walled, much branched. *Basidiospores* 10.5–13.5 (–14.5) × 7.0–9.0 (–10.0) µm, including myxosporium and 8.0–9.0 × 5.5–7.0 µm, excluding myxosporium; ovoid; brown, with a dark brown eusporium bearing few and thick echinulae, overlaid by a hyaline myxosporium, truncate or not at the apex. *Basidia* not seen. *Cutis* hymenodermic; elements 20–60 × 4.0–8.0 µm, clavate, amyloid in Melzer's reagent.

Specimens examined: **China**: **Anhui**, Dabieshan, cultivated, 5 June 2002, G.-H. Xi, HMAS 77021. **Guangxi**, Rong'an, cultivated, 22 May 2002, N. Li 2, HMAS 77023. **Guizhou**, Ceheng, Ronghong, on rotten wood, 2 July 1986, X.-L. Wu 1012, HMAS 62422 (originally identified as *G. formosanum*); Leigongshan, on rotten wood, 26 May 1986, X.-L. Wu 0234, HMAS 61789; Libo, Maolan, on rotten wood, 25 April 1984, X.-L. Wu 0692, HMAS 66205. **Hainan**, purchased from market, July 2002, Y.-C. Dai HN213, HMAS 97364; Anding, 19 Dec. 1934, X.-K. Deng 7709, HMAS 7509; Diaoluoshan, on rotten wood of hardwood trees, 13 Dec. 2003, D.-M. Wang, wdm37, HMAS 97368; Diaoluoshan, on rotten wood, 12 Dec. 2003, S.-M. Huang, wdm25, HMAS 97367; Diaoluoshan, on the ground with rotten wood of hardwood trees, 13 Dec. 2003, D.-M. Wang 32L, HMAS 130316 and 32S, HMAS 97366; Jianfengling, Sept. 1969, D.-Z. Wang, HN20, HMAS 37722 (holotype of *G. sinense* Zhao, Xu & Zhang); Jianfengling, on the base of *Dacrydium pierrei* Hichel, Sept. 1969, J. Huang, HN17, HMAS 37870; Jianfengling, on the ground with falling wood, 14 Nov. 1969, Y.-N. Yu et al., HN19, HMAS 37869; Wuzhishan, on hardwoods, 1 Feb. 2002, Z.-C. Xie, HMAS 76761. **Jiangxi**, Wanzai, cultivated, 1995, Y.-X. Li and H.-B. Yang 9519, HMAS 76498. **Zhejiang**, Xianju, cultivated on *Tilia* sp., 15 May 2001, Z.-Y. Wang 3, HMAS 77001. **Taiwan**, Tauiyuen, on the stem bases of the Formosan sweet gum

(*Liquidambar formosana* Hance), Oct. 1981, T.-T. Chang, TAI 8002 (holotype of *G. formosanum* Chang & Chen).

Distribution: China and Japan (Zhao & Zhang 2000).

The above description is mainly based on the specimens cited above, but the type of *G. sinense* has now become very scanty. It is sad to record that the type comprises only a part of a pileus, compared to the complete basidioma with a long and thin stipe as illustrated in Zhao et al. (1979), where *G. sinense* was published as a new species.

This species is frequently referred by Chinese authors (e.g. Teng 1934, 1939, 1963) to either *G. lucidum* or *G. japonicum*. *Ganoderma sinense* differs from *G. lucidum* in thin-fleshed basidiomata, with longated, slender stipes, rarely branched skeleto-ligative hyphae, together with hyaline *Bovista*-type ligative hyphae (Pegler & Yao 1996). *Ganoderma japonicum* has a yellow pileus when young, red brown or rusty brown at maturity and off-white context (Pegler & Yao 1996), and is distinguished from the purplish black to black pileus and brown context in *G. sinense*.

Ganoderma formosanum is a species described from Taiwan by Chang & Chen (1984) and is very similar to *G. sinense* in habit and both macro- and microscopical morphology. The former species was accepted as a distinct species for the duplex context and ovoid basidiospores with persistent apex by Zhao & Zhang (2000) and this conclusion was followed by Wu & Dai (2005). By examination of the holotype of *G. formosanum* and the specimens of *G. sinense* including the holotype, it is concluded here that the differences used for the discrimination between these two taxa resulted from variable characters and incomplete description. The papillate apex of basidiospores (Chang & Chen 1984) can vary in length and is not persistent, easily broken in old specimens, e.g. the holotype of *G. formosanum*. The elongated depressions on the basidiospores of *G. formosanum* were also observed in specimens of *G. sinense*, although these were not described by Zhao et al. (1979) and Zhao & Zhang (2000). On the context color, Chang & Chen (1984) mentioned that *G. formosanum* had context of a white thin upper part and a dark brown (as 'Warm Sepia, Auburn') lower part next to the tube layer, whilst Zhao et al. (1979) reported uniformly brown context in *G. sinense*. In the present study, it was noticed that the context in some specimens of *G. sinense* was brown with white patches or becoming woody near the cutis. Furthermore, ITS sequences from collections named as the two taxa were very similar to each other (Moncalvo et al. 1995b) and this was also confirmed by this study (data not shown). Based on both morphological and molecular data, it is concluded here that *G. formosanum* and *G. sinense* are synonyms and the latter is the correct name to be used.

Ganoderma weberianum (Bres. & Henn. ex Sacc.) Steyaert in Persoonia **7**: 79 (1972). **Figs 7–10**

=*Fomes weberianus* Bres. & Henn. ex Sacc., Syll. Fung. **9**: 174 (1891).

=*Ganoderma microsporum* R.S. Hseu in Mycotaxon **35**: 36 (1989).

Misapplications:

Ganoderma subumbraculum Imazeki in Pilát in Ann. Mycol. **38**: 79 (1940), non Imazeki in Bull. Nat. Sci. Mus. Tokyo **1**: 38 (1939).

Ganoderma capense (Lloyd) Teng in Teng, Fungi of China: 448 (1963) pro part., non *Polyporus capensis* Lloyd, Mycol. Writ. **5**, Let. **63**: 10 (1916).

Basidioma annual, sessile to stipitate, corky-woody. *Pileus* 1.5–4.5 × 3.5–5.0 cm, 0.2–0.5 cm thick, flabelliform to conchate, applanate or convex; upper surface initially yellow, then with a transitional yellowish red zone to purplish black, almost black at maturity; concentrically and narrowly zonate or sulcate, radially and finely rugose, strongly laccate; margin thin, sometimes incurved, broadly sterile below, white when young, yellowish red or almost black at maturity. *Pore surface* at first cream-white, then vividly yellow, staining dark brown at maturity or on bruising; tubes up to 2 mm long, grey-brown, contrasting with context; pores 5–6 per mm, circular, 120–160 µm diam., dissepiments 20–80 µm thick. *Stipe* 0.7–1.0 × 0.4–1.5 cm, horizontal or dorsally lateral, stumpy or cylindrical; almost black, strongly laccate. *Context* 2–4 mm thick, uniformly pale buff or upper layer pale woody or pale buff, lower layer cinnamon brown; usually with thin, shiny and horn-like deposits, with a few gasterospores; hyphal system trimitic; generative hyphae 3.0–5.0 µm diam., hyaline, thin-walled, with clamp-connexions; skeletal hyphae 4.0–6.5 µm diam., hyaline to pale yellow in 5% KOH solution, dextrinoid in Melzer's reagent; ligative hyphae 1.0–2.5 µm diam., abundant near the cutis, thick-walled. *Basidiospores* 6.0–9.0 × 4.5–6.5 µm, including myxosporium and 4.5–7.0 × 3.5–4.5 µm, excluding myxosporium; ovoid to subspherical; brown, with a dark brown eusporium bearing fine and barely visible echinulae, overlaid by a hyaline myxosporium. *Basidia* not seen. *Cutis* hymenodermic; elements 40–90 × 5.0–12.0 µm, clavate, amyloid in Melzer's reagent.

Specimens examined: **China:** Beijing, Huairou, Edible Mushroom Farm, cultivated from AS 5.71 in the China General Microbiological Culture Collection Centre (CGMCC) labelled as *G. capense* from Hainan, 27 Aug. 2003, D.-M. Wang, HMAS 97365. **Taiwan**, Taipei, on *Salix babylonica* Linn., 21 Aug. 1983, R.-S. Hseu, HMAS 57945 (isotype of *G. microsporum* Hseu). **Tianjin**, habit unrecorded, 27 Oct. 1925, Emilio Licentio 1266, HMAS 10475 (originally identified as *G. subumbraculum* Murrill by A. Pilát). **Yunnan**, Xiaguan, on rotten wood of broad-leaved tree, 24 Aug. 1985, Q.-X. Wu 544, HMAS 54010 (originally identified as *G. capense* and redetermined as *G. microsporum* by X.-Q. Zhang).

Distribution: Africa, Indonesia and Samoa Islands (Steyaert 1972); Australia, South-east Asia and the Pacific regions (Smith & Sivasithamparam 2003); North of China (this study).

The above description was mainly based on the isotype of *G. microsporum* and is similar to that of Hseu et al. (1989), although gasterospores and horny-like deposits were not mentioned in the protologue. All the specimens examined in this study have horizontal to dorsally lateral stipe, flabelliform to conchate pileus with concentrically colored zones and distinct, fine wrinkles, light-colored context, and small basidiospores (6.0–9.0 × 4.5–6.5 µm) with short and barely visible interpillar echinulae. These features basically conform to the descriptions of *G. weberianum* (Bres. & Henn. ex Sacc.) Steyaert (see Steyaert 1972). The phylogenetic analysis of ITS sequences from the strain named *G. capense* in this study (data not shown), the holotype of *G. microsporum* (Moncalvo et al. 1995a, X78751 and X78772), and collections of *G. weberianum* from eastern Asia (Moncalvo et al. 1995a, X78751 and X78772; Moncalvo et al. 1995b, Z37064 and Z37086) and from Australia (Smith & Sivasithamparam 2000, sequences not deposited in the public databases), also suggested the conspecific relationship of these collections.

According to the principle of priority in the ICBN (Greuter et al. 2000), *G. weberianum* is the correct name for use.

Teng (1963) reported *G. capense* from Yunnan and Hainan, China, with description of a dark purplish pileus, $7-12 \times 11-19 \times 1-1.5$ cm, woody context, lateral and stumpy stipe when present, and small basidiospores $7.5-10 \times 5.5-7$ μm . This description is very similar to that of *G. weberianum*. The living strain, AS 5.71 from which HMAS 97365 (cited above) was cultivated, was apparently named after Teng's (1963) concept as '*Ganoderma capense* (Lloyd) Teng', isolated by Guangdong Institute of Microbiology from Hainan. However, examination of two other specimens in HMAS determined as *G. capense* by S.-C. Teng, HMAS 31829 and HMAS 23627, showed that they belonged to other species. HMAS 31829 differed from *G. weberianum* by red brown context, short crust elements (less than 20 μm long) and larger basidiospores (reaching 11.5×7.0 μm) with distinct echinulae, and HMAS 23627 also has larger basidiospores ($9.0-10.5 \times 6.0-8.0$ μm) although it is macroscopically similar to *G. weberianum*.

Ganoderma subumbraculum was published as a new species with strongly convex pileus, centrally attached stipe, three-layer context, cinnamon to off-white to dark cinnamon from cutis to tube layer and ovoid basidiospores $11-12 \times 7-7.5$ μm (Imazeki 1939). HMAS 10475 was identified as *G. subumbraculum* by Pilát (1940) and accepted by Zhao & Zhang (2000). Examination of the specimen in the present study showed typical morphological characters of *G. weberianum* and is almost identical to HMAS 97365 (cultivated from AS 5.71).

Steyaert (1972) mentioned two different sizes of cuticular elements in *G. weberianum* as $30 \times 7-8$ μm and $20 \times 10-12$ μm , and concluded that the collections with the former only had a few gasterospores in the context whilst those with the latter produced gasterospores in abundance. The variability in producing gasterospores was also found in the present study, very abundant in HMAS 97365 and HMAS 10475, a few in HMAS 57945 and none in HMAS 54010. The correlation between the size of cuticular elements and the gasterospore number, however, was not confirmed. The incongruence of cutis description between Steyaert (1972) and this study might result from different sampling sites, because the development of the cutis varies with age (see also Ryvarden 1995).

It was also noticed in this study that collections of *G. weberianum* might display horizontal stipe and distinct colored-zones on upper surface of pileus when young, becoming dorso-lateral stipe and almost black pileus surface at maturity, e.g. HMAS 57945 (Fig. 1A) and HMAS 10475.

Ganoderma weberianum was reported as a tropical species by Steyaert (1972). The record in Tianjin, as specimen cited above, extends the distribution of this species to the north temperate zone. A distribution in temperate and tropical south east Asia, central to north-eastern Australia and Pacific regions was specified by Smith & Sivasithamparam (2003) although no evident specimens from all of these areas were cited in their work.

Ganoderma microsporum Hseu is a recent synonym and should not be used. The distribution of *G. subumbraculum* in China should also be excluded because the only record was reported by referring to one specimen (HMAS 10475), which proved to be *G. weberianum* as shown above.

Ganoderma guangxiicum X.L. Wu in Wu & Dai, Col. Illu. *Ganodermataceae* China: 145 (2005).

This is a recently proposed new species as ‘*Ganoderma guangxiica* X.L. Wu sp. nov.’, with description in Chinese, in an illustration book (Wu & Dai 2005). The Latin diagnosis and designation of the type were lacking. According to Articles 32.1, 36.1 and 37.1 of ICBN (Greuter et al. 2000), this is an invalid name and is in need of validation. However, from the description and illustrations of the species provided in Wu & Dai (2005), it is not a typical member of *Ganoderma*, because the basidiospores were smooth without echinulae and not truncate at the apex.

Acknowledgements

The authors are grateful to Professors D. N. Pegler and H. Knudsen for serving as pre-submission reviewers and for their valuable comments and suggestions, to Dr S.-H. Wu for the loan of the holotype of *Ganoderma formosanum*, to Dr. Y.-C. Dai and Mr. S.-M. Huang for the gift of *G. sinense* specimens and to Drs X.-Z. Liu, B. Liu, G.-Z. Zhao and Miss M.-H. Sun for their kind help in a field trip to Hainan. This project is supported by the Key Research Direction of Innovation Programme (KSCX2-SW-101C) and the scheme of Introduction of Overseas Outstanding Talents, operated by the Chinese Academy of Sciences, a project grant (30270006) and the National Science Fund for Distinguished Young Scholars (30025002) from the National Nature Science Foundation of China, and the National Hi-Tech Research and Development Plan (2004AA227100) from the Ministry of Science and Technology.

Literature cited

- Chang T-T, Chen T. 1984. *Ganoderma formosanum* sp. nov. on Formosan sweet gum in Taiwan. Transactions of the British Mycological Society **82**: 731–733.
- Greuter W, McNeill J, Barrie FR, Burdet HM, Demoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Trehane P, Turland NJ, Hawksworth DL. 2000. International Code of Botanical Nomenclature (Saint Louis Code). Koenigstein, Germany: Koeltz Scientific Books. 1–474.
- Hseu R-S, Chen Z-C, Wang H-H. 1989. *Ganoderma microsporum*, a new species on weeping willow in Taiwan. Mycotaxon **35**: 35–40.
- Imazeki R. 1939. Studies on *Ganoderma* of Nippon. Bulletin of the National Science Museum, Tokyo **1**: 29–52.
- Moncalvo J-M, Wang H-H, Hseu R-S. 1995a. Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. Mycologia **87**: 223–238.
- Moncalvo J-M, Wang H-F, Wang H-H, Hseu R-S. 1995b. The use of ribosomal DNA sequence data for species identification and phylogeny in the *Ganodermataceae*. In: *Ganoderma*: Systematics, Phytopathology and Pharmacology. Proceedings of Contributed Symposium 59A, B, 5th International Mycological Congress, Vancouver, August 14–21, 1994. (eds Buchanan PK, Hseu R-S, Moncalvo J-M), pp 31–44. Taipei: National Taiwan University.
- Pegler DN, Yao Y-J. 1996. Oriental species of *Ganoderma* section *Ganoderma*. In: Botany and Mycology for the Next Millennium: Collection of Scientific Articles Devoted to the 70th Anniversary of Academician K. M. Sytnik (ed Wasser SP), pp 336–347. Kyiv: N. G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine.
- Pegler DN, Young TWK. 1973. Basidiospore form in the British species of *Ganoderma* Karst. Kew Bulletin **28**: 351–364.

- Pilát A. 1940. Basidiomycetes chinenses a cel. Emilio Licentio in itineribus per Chinam septentrionalem annis 1914–1936 susceptis, lecti. *Annales Mycologici* **38**: 61–82.
- Ryvarden L. 1995. Can we trust morphology in *Ganoderma*? In: *Ganoderma: Systematics, Phytopathology and Pharmacology*. Proceedings of Contributed Symposium 59A, B, 5th International Mycological Congress, Vancouver, August 14–21, 1994. (eds Buchanan PK, Hseu R-S, Moncalvo J-M), pp 19–24. Taipei: National Taiwan University.
- Smith BJ, Sivasithamparam K. 2000. Internal transcribed spacer ribosomal DNA sequence of five species of *Ganoderma* from Australia. *Mycological Research* **104**: 943–951.
- Smith BJ, Sivasithamparam K. 2003. Morphological studies of *Ganoderma* (*Ganodermataceae*) from the Australasian and Pacific regions. *Australian Systematic Botany* **16**: 487–503.
- Steyaert RL. 1972. Species of *Ganoderma* and related genera mainly of the Bogor and Leiden Herbaria. *Persoonia* **7**: 55–118.
- Teng S-C. 1934. Notes on *Polyporaceae* from China. *Sinensia* **5**: 173–244.
- Teng S-C. 1939. A Contribution to Our Knowledge of the Higher Fungi of China. Beijing: National Institute of Zoology & Botany, Academia Sinica. 1–614.
- Teng S-C. 1963. Fungi of China. Beijing: Sciences Press. 1–808. (in Chinese).
- Wu X-L, Dai Y-C. 2005. Coloured Illustrations of *Ganodermataceae* of China. Beijing: Science Press. 1–229. (in Chinese).
- Zhao J-D. 1988. Studies on the taxonomy of *Ganodermataceae* in China IX. Subgenus *Elfvigia* (Karst.) Imazeki. *Acta Mycologica Sinica* **7**: 13–22. (in Chinese).
- Zhao J-D. 1989. The *Ganodermataceae* in China. *Bibliotheca Mycologica* **132**: 1–176.
- Zhao J-D, Xu L-W, Zhang X-Q. 1979. Taxonomic studies of the subfamily *Ganodermatoideae* of China. *Acta Microbiologica Sinica* **19**: 265–279. (in Chinese).
- Zhao J-D, Xu L-W, Zhang X-Q. 1981. *Ganodermatoideae* of China. Beijing: Science Press. 1–106. (in Chinese).
- Zhao J-D, Zhang X-Q. 2000. Flora Fungorum Sinicorum. **18**: *Ganodermataceae*. Beijing: Science Press. 1–204. (in Chinese).

Parmeliaceae (Ascomycota) lichens in China's mainland
IV. *Melanelia* species new to China

JIAN-BIN CHEN

chenjbin@yahoo.com

Systematic Mycology & Lichenology Laboratory, Institute of Microbiology
Chinese Academy of Sciences, Beijing 100080, China

THEODORE L. ESSLINGER

Ted.Esslinger@ndsu.edu

Department of Biological Sciences, Stevens Hall, Box 5517
North Dakota State University, Fargo, ND 58105-5517, U.S.A.

Abstract—Four *Melanelia* species are reported as new to China: *Melanelia exasperata*, *M. poeltii*, *M. tominii* and *M. villosella*.

Key words—brown *Parmeliae*, new distribution, Asia

Introduction

The brown species of *Parmelia* were first revised by Esslinger (1977) who initially recognized three subgenera: *Allantoparmelia* (Vain.) Essl., *Neofusca* (Gyeln.) Essl., and *Melanoparmelia* (Hue) Essl. Later (Esslinger 1978), these three taxa were raised to genus level, with subgenus *Melanoparmelia* becoming *Melanelia* Essl. These segregates have been widely, although not universally, accepted, and a recent paper (Blanco et al. 2004) using molecular, morphological, and chemical data has proposed a further rearrangement in which the majority of the species of *Melanelia* are segregated into at least two more genera, *Melanelixia* O. Blanco et al. and *Melanohalea* O. Blanco et al. Since that research is ongoing and a complete arrangement for all species of *Melanelia* was not provided, we have chosen in this paper to continue to use the genus *Melanelia* in its original sense.

Melanelia species are characterized by a foliose thallus, with an olive-brown to black brown upper surface (K–, HNO₃–); pseudocyphellae, soredia, or isidia may be present, and a few species have tiny, hyaline cortical hairs. The lower surface has simple, moderate to sparse rhizinae. Typically, they contain orcinol depsides or β-orcinol depsidones in the medulla, although this is one of the few parmelioid groups with some species totally lacking medullary lichen compounds. As originally circumscribed, the genus *Melanelia* comprises about 40 species, distributed mainly in temperate to boreal regions of the Northern Hemisphere. In China nine species of *Melanelia* were reported in the enumeration by Wei (1991): *M. elegantula* (Zahlbr.) Essl., *M. exasperatula* (Nyl.) Essl., *M. fuliginosa* (Fr. ex Duby) Essl., *M. glabra* (Schaerer) Essl., *M. huei* (Asahina) Essl., *M. olivacea* (L.) Essl., *M. sorediata* (Ach.) Goward & Ahti, *M. stygia*

(L.) Essl., and *M. subverruculifera* (J.C. Wei & Y.M. Jiang) J.C. Wei. A tenth species, *M. subargentifera* (Nyl.) Essl., was reported from Xinjiang by Abbas and Wu (1998).

Recently, Zibirnisa et al. (2004) reported *M. glabroides* (Essl.) Essl., and *M. tominii* (Oxner) Essl. from Xinjiang in China. However, the report is brief and lacks a discussion, important synonyms, and related literature citations under each species. Also, these authors state that *M. tominii* contains lecanoric acid and gyrophoric acid, which puts the record in doubt. Our studies show *M. tominii*, which we herein report from three provinces of China, contains gyrophoric acid as the major lichen substance but lacks lecanoric acid. This is also in agreement with the results of Esslinger (1977, 1992). Our studies show that *M. exasperata*, *M. poeltii*, *M. subargentifera*, and *M. villosella* should also be added to the Chinese lichen flora.

Materials and methods

The specimens studied from mainland China are housed in HMAS-L (Lichen Section, Herbarium of the Institute of Microbiology, Academia Sinica) unless otherwise indicated. The morphology of the lichen specimens was examined using a Zeiss stereo microscope and Zeiss compound microscope. Chemical constituents were identified by thin layer chromatography (Culberson 1972).

The species

1. *Melanelia exasperata* (De Not.) Essl., Mycotaxon 7: 47 (1978).

=*Parmelia exasperata* De Not., Giorn. Bot. Ital. 2: 193 (1847).

This species is characterized by the numerous, more or less evenly scattered, conical to short-cylindrical papillae bearing distinctive pseudocyphellae at the tip, by the lack of soredia and true isidia, and by the absence of lichen substances in the medulla (K–, C–, KC–, PD–). The papillae or warts of *M. exasperata* have sometimes been referred to as isidia, but they are not true isidia, since they rarely if ever become detached. *Melanelia elegantula* and *M. laciniatula* have similar papillae, although they are usually smaller. In *M. elegantula* these papillae usually elongate to form cylindrical, usually branched isidia, and in *M. laciniatula* they often expand to form the lobules which more or less cover the central part of the thallus. By contrast, the papillae in *M. exasperata* are usually short, broad-based and more or less conical, or become short-cylindrical but they remain quite firm and are unlikely to break off with any frequency.

Melanelia exasperata has been reported from North America, Europe and North Africa (Esslinger 1977). New to China.

Specimen examined: CHINA. Xinjiang, Kermasen, A. Abbas 9600229.

2. *Melanelia poeltii* Essl., Mycotaxon 28: 215 (1987).

This species is characterized by the narrow lobes (1–3mm wide), isidia which arise as small spherical papillae and become cylindrical to rather irregular, becoming short branched, the sparse pseudocyphellae (absent on some lobes), and the presence of fumarprotocetraric acid in the medulla (PD+ red-orange or PD– only in some older thallus parts, K–, C–, KC–). *Melanelia poeltii* is similar to *M. elegantula* in habit and habitat, but the latter species lacks detectable lichen substances. In fact, *M. poeltii* is

the only member of the genus with true isidia which contains fumarprotocetraric acid. Among other isidiate species, *M. elegantula*, *M. infumata*, *M. exasperatula* and *M. subelegantula* lack detectable lichen substances, and *M. fuliginosa* contains lecanoric acid (C+ red). Although *M. olivaceoides* also contains fumarprotocetraric acid and has isidia-like progagules, they are actually isidioid soredia rather than true isidia. Also, *M. olivaceoides* lacks pseudocyphellae.

Melanelia poeltii was previously known only from Nepal (Esslinger 1987). New to China, but known only from Sichuan of southwest China).

Specimen examined: CHINA. Sichuan, Maerkang, Mt. Mengbishan, alt. 4100m, on bark, X. Y. Wang & X. Xiao 11553.

3. *Melanelia tominii* (Oxner) Essl., Lichenologist **24**: 17 (1992).

- = *Parmelia tominii* Oxner, Zh. Bio.-Bot. Tsyklu, Kyev **1933(7-8)**: 171 (1933).
- = *Parmelia substygia* Räsänen, Lichenes Fenniae Exs. **51** (1935).
- = *Melanelia substygia* (Räsänen) Essl., Mycotaxon **7**: 47 (1978).
- = *Parmelia borisorum* Oxner, Bot. Zh., Kyiv **1**: 33 (1940).
- = *Parmelia saximontana* R.A. Anderson & W.A. Weber, Bryologist **65**: 236 (1962).
- = *Parmelia altaica* Oxner, Ukr. Bot. Zh. **27**: 175 (1970).

This species is characterized by the rather narrow lobes (1-3 mm wide), the laminal, distinct to somewhat obscure pseudocyphellae, the presence of gyrophoric acid in the medulla (K–, PD–, C+ rose–red), and the saxicolous habit. Most specimens have laminal and marginal, punctiform to capitate soralia composed of granular soredia, although, with varying frequency, esorediate specimens occur throughout much of its range. *M. tominii* is distinguished from other similar sorediate species by the presence of gyrophoric acid rather than perlatolic and stenosporic acids (C–) which occur in *M. disjuncta* and *M. sorediata*. In addition, *M. sorediata* lacks pseudocyphellae, and *M. disjuncta* has only submarginal pseudocyphellae which are often indistinct and obscure. After studying the relevant type specimens, Esslinger (1992) reduced *Parmelia altaica*, *P. borisorum* and *P. substygia* as synonyms of *M. tominii*. The morphological and chemical variation of this species were discussed by Krog (1966) and Esslinger (1977 & 1992).

As mentioned, *Melanelia tominii* is considered to be a sorediate species, but some specimens lack soredia or have only a few soredia. Chinese specimens of this species examined by us lack soredia. Esorediate specimens of *M. tominii* can be distinguished from similar esorediate species by its distinctive chemistry. In *M. tominii* the major medullary substances are gyrophoric acid, slightly smaller amounts of ovoic acid [reported originally as unknown W.G.-2 by Esslinger (1977)], and a trace of unknown W.G.-1. Rarely, as in the type specimen of *M. borisorum*, ovoic acid is replaced by umbilicic acid (Esslinger 1992). Therefore, the report by Zibirnisa et al. (2004) of a Chinese specimen of *M. tomini* containing lecanoric acid as a major component may be based on a misidentification or other error.

Melanelia tominii is widely distributed in the Northern Hemisphere: North America, Europe, and Asia (Pakistan, Nepal, Mongolia, Siberia, and Kazakhstan).

Representative specimens examined: CHINA. Beijing, Mt Donglingshan, alt. 2250m, C. M. Wetmore 75102 (Herb. Esslinger). Neimengguo, Balingyouqi, alt. 1400m, J. B. Chen 20182, 20220. Sichuan, Mt. Gonggashan, alt. 3300m, X. Y. Wang et al. 8987.

4. *Melanelia villosella* (Essl.) Essl., Mycotaxon 7: 49 (1978)

= *Parmelia villosella* Essl., J. Hattori Bot. Lab. 42: 95 (1977).

This species is characterized by the cylindrical isidia and numerous cortical hairs on the upper surface and isidia, and the presence of lecanoric acid in the medulla (K–, P–, C+ red). *Melanelia villosella* is a very distinctive species not easily mistaken for any other. Closely related *M. subargentifera* occasionally has pustular soredia which might be confused for the isidia of *M. villosella*, except the pustules eventually break apart forming soredia and the true isidia do not. *Melanelia piliferella* (Essl.) Essl. from Australia is similar to *M. villosella*, with isidia and cortical hairs, but *M. piliferella* is a much finer species and contains gyrophoric acid rather than lecanoric acid.

Melanelia villosella occurs in Asia (India and Pakistan) (Esslinger 1977) and North America (Arizona) (Esslinger 2002). New to China.

Representative specimens examined: CHINA. Shaanxi, Mt. Taibeishan, alt. 2800m, X. Q. Gao 2995, Sichuan, Xiaaba, alt. 3100 m, X. Y. Wang & X. Xiao 11192.

Acknowledgements

The first author would like to thank the National Natural Science Foundation of China (30370007) for support of this research. The authors also wish to thank Prof. Abdulla Abbas for providing several specimens, and the two pre-submission reviewers, Dr. Robert Egan and Dr. Bruce McCune, for their helpful suggestions.

Literature cited

- Abbas Abdulla & Wu Ji-Nong. 1998. Lichens of Xinjiang. 178 pp. Sci-Tech & Hygiene Publishing House of Xinjiang, Urumqi.
- Blanco O, Crespo A, Divakar PK, Esslinger TL, Hawksworth DL & Lumbsch, HT. 2004. *Melanelixia* and *Melanohalea*, two new genera segregated from *Melanelia* (Parmeliaceae) based on molecular and morphological data. Mycological Research 108 (8): 873-884.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. Journal of Chromatography 72: 113-125.
- Esslinger TL. 1977. A chemosystematic revision of the brown Parmeliae. Journal of the Hattori Botanical Laboratory 42: 1-211.
- Esslinger TL. 1978. A new status for the brown Parmeliae. Mycotaxon 7: 45-54.
- Esslinger TL. 1987. A new species of *Melanelia* from Nepal. Mycotaxon 28: 215-217.
- Esslinger TL. 1992. The brown *Parmelia* type specimens of A. N. Oxner. Lichenologist 24: 13-20.
- Esslinger TL. 2002. *Melanelia*, pp. 274-286 In Nash TH, III et al. (eds): Lichen Flora of the Greater Sonoran Desert Region, Vol. I. Lichens Unlimited, Arizona State University, Tempe, Arizona.
- Frisch A & Hertel H. 1988. Flora of macrolichens in the alpine and subalpine zones of Mount Kenya (Kenya). Sauteria 9: 363-370.
- Krog H. 1966. Notes on the distribution of *Parmelia saximontana* Anderson & Weber. Blyttia 24: 244-246.
- Wei JC. 1991. An enumeration of lichens in China. 278 pp. International Academic Publishers, Beijing.
- Zibirnisa Omar, Aziguli Keyimu & Abdulla Abbas. 2004. New Chinese records of the lichen genus *Melanelia*. Acta Botanica Yunnanica 26: 385-386. [NOTE: Although the third author's surname is Abbas and his given name Abdulla, this journal (and some others) presents it in reverse, as given here, both on the title page and on the journal contents page.]

Myxomycetes from Chihuahua, Mexico III

M. LIZÁRRAGA ¹, G. MORENO ², C. ILLANA ² & H. SINGER ²

1.- mlizarra@uacj.mx

*Programa de Biología, Ciencias Básicas, Instituto de Ciencias Biomédicas
Universidad Autónoma de Ciudad Juárez*

Anillo Envolvente y Estocolmo s/n, 32300 Ciudad Juárez, Chihuahua, Mexico

2.- gabriel.moreno@uah.es

*Dpto. Biología Vegetal, Fac. Biología, Universidad de Alcalá
28871 Alcalá de Henares, Madrid, Spain*

Abstract—19 taxa of *Myxomycetes* from the state of Chihuahua are described. Six of them are new records for Mexico: *Dianema corticatum*, *Macbrideola synsporos*, *Perichaena syncarpon*, *Physarum newtonii*, *Symphytocarpus amaurochaetoides* and *Trichia decipiens* var. *olivacea*. The others are new records for the state of Chihuahua: *Badhamia nitens* var. *aurantiaca*, *Clastoderma debaryanum*, *Craterium paraguayense*, *Comatricha elegans*, *C. tenerrima*, *Diderma effusum*, *Lamproderma gulielmae*, *Macbrideola cornea*, *Physarum didermoides*, *P. cinereum*, *Trichia agaves*, *T. varia* and *Willkommlangea reticulata*. Microphotographs of the taxa new for Mexico or little known species are given.

Key words — *Myxomycota*, SEM, taxonomy, chorology

Introduction

This work is a continuation of our studies on the *Myxomycetes* of the state of Chihuahua (Lizárraga et al. 2003, 2005), in which 87 taxa have been described. With the present contribution the number increases to 106 taxa. Veracruz and Tlaxcala are the states with major diversity of *Myxomycetes* with 133 and 112 taxa, respectively, followed by Baja California with 88.

Some of the described species, such as *Comatricha elegans*, *Dianema corticatum*, *Lamproderma gulielmae*, *Macbrideola synsporos*, *Perichaena syncarpon*, *Physarum newtonii*, *Symphytocarpus amaurochaetoides* and *Willkommlangea reticulata* are rare or little known taxa worldwide. Therefore, SEM photographs of their spore ornamentation are provided, in some cases the first ones published.

Materials and Methods

All the material has been either collected in the field or obtained in moist chamber cultures. The intention of the current work is to complete the information about ecology and chorology.

The specimens are deposited in the Herbarium UACJ of the “Departamento Ciencias Básicas Universidad Autónoma de Ciudad Juárez”, Mexico. A duplicate of rare species or species new for Mexico are deposited in the herbarium AH of the “Departamento de Biología Vegetal (Botánica), Universidad de Alcalá, Alcalá de Henares, Madrid”, Spain.

Detailed descriptions are given only for species that are first records for Mexico.

The collected material was mounted in Hoyer's medium and studied with a Nikon (Optiphot) microscope. Scanning electron microscopy (SEM) images were made with a Zeiss DSM-950. The optical microscope (OM) was used to make spore measurements under oil immersion and include surface structures such as spines or warts. Observations of the spore ornamentation by SEM have been made after applying the critical point drying technique as indicated in Moreno et al. (2002).

List of Species

Badhamia nitens* var. *aurantiaca (Lizárraga, G. Moreno & Illana) Lizárraga, G. Moreno & Illana, Mycotaxon 63: 289. 1997

≡ *Badhamia aurantiaca* Lizárraga, G. Moreno & Illana, in Lizárraga, Moreno, Illana & Castillo, II Congreso Internacional de Sistemática y Ecología de Myxomycetes, ICSEM2, Madrid: 56. 1996

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Cumbres de Majalca, on bark of *Quercus* sp., leg. M. Lizárraga, G. Mendoza, H. Pelayo & P. García, obtained in moist chamber culture on 14-VI-2004, UACJ 647.

COMMENTS — *Badhamia nitens* var. *aurantiaca* is characterized by its sessile sporocarps, growing solitarily or in groups, with a single, orangish to ocraceous orangish peridium, its calcareous, orange capillitium with big nodes forming a three-dimensional net and by its spores forming clusters of 3-18 spores, each spore being subglobose to pyriform, 10-12 μm in diam., ornamented on 2/3 of its surface with spines, the other third lacking spines. In Mexico this variety is only known from Baja California (Lizárraga et al. 1997). *Badhamia nitens* var. *nitens* Berk. that has yellowish colorations has been cited from Baja California (Lizárraga et al. 1997) and Tlaxcala (Hernández-Cuevas & Estrada-Torres 1993).

Clastoderma debaryanum A. Blytt, Bot. Zeitung (Berlin) 38: 343. 1880

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Basaseachic, Ocampo, on decomposing wood, leg. M. Lizárraga & H. Pelayo, 9-X-2004, UACJ 811, 813, 814 and 818.

COMMENTS — This species has been cited in Mexico in the states of Jalisco, Quintana Roo, Sinaloa, Veracruz (Illana et al. 2000) and recently from Yucatán (Stephenson et al. 2003).

Comatricha elegans (Racib.) G. Lister, Guide Brit. Mycetoza, ed. 3: 31. 1909

FIGURES 1-3

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** San Bernabé Cusihiachi, Cuahutemoc, on bark of *Quercus* sp., leg. E. Orozco, obtained in moist chamber culture

on 07-I-2004, UACJ 577 in AH 31773 (together with *Macbrideola synsporos*). *Ibidem*, 12-III-2004, UACJ 611 and 652 in AH 31774.

COMMENTS — *Comatricha elegans* is characterized by its small, reddish brown sporocarps, with a columella typically splitting into several thick capillitium branches. The globose spores, 9-10 μm in diam., show an ornamentation formed by spines; under SEM dense baculae can be observed.

In order to determine this species we have followed the concept of Lister (1925), who drew sporocarps with a columella and ramifications as in our material. Recently Mitchell (2004) describes a *Comatricha elegans* collection with “primary branches of the capillitium arising abruptly either from the top of the stalk (columella absent) or from the tip of a short columella that rarely reaches to the centre of the sporotheca”.

This species has been cited previously from Jalisco and Veracruz (Illana et al. 2000).

Comatricha tenerrima (M. A. Curtis) G. Lister, Guide Brit. Mycetoza, ed. 4: 39. 1919

FIGURE 4

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: San Bernabé Cusihiaciachi, Cuahutemoc, on stems of *Quercus* sp., leg. E. Orozco, obtained in moist chamber culture on 8-III-2004, UACJ 612 (together with *Macbrideola synsporos*).

COMMENTS — *Comatricha tenerrima* differs macroscopically by its sporocarps with sporothecae ending in a pointed apex and by its lax and spiny spore ornamentation. When viewed under SEM, the spore ornamentation is formed by characteristic baculae with stellate apices.

The spore ornamentation of this species agrees with the studies of Rammeloo (1983). The species was cited previously from Baja California, Guerrero, Jalisco and Tlaxcala (Illana et al. 2000) and from the states of Quintana Roo and Veracruz (Lado et al. 2003).

Craterium paraguayense (Speg.) G. Lister in Lister, Monogr. Mycetoza, ed. 2: 95. 1911

FIGURES 17-18

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Rancho “Las Tinajas”, ctra. a Namiquipa km. 15, Chihuahua, on leaves of *Quercus* sp., leg. M. Lizárraga, H. Pelayo, E. Alvarez & L. de la Rosa. 27-VIII-2004, UACJ 679, 681, 682 in AH 31775 and 713.

COMMENTS — This species is characterized by its stalked sporocarps, its cylindrical, violaceous sporotheca with circumscissile dehiscence and by its capillitium that is also violaceous.

Castillo et al. (2002) did a comparative SEM study of the types of *Craterium paraguayense* and *Physarum newtonii* T. Macbr., as sometimes they can be confused macroscopically. The spore ornamentation of these two species is very different, as in the case of *P. newtonii* the strong spines seen with LM, are seen under SEM as very pronounced baculae. In the case of *C. paraguayense* the spores appear as small warts under LM, and under SEM as small verrucae alternating with short baculae. We have been able to confirm this type of spore ornamentation in the collections of Chihuahua.

This species, described from Paraguay (therefore its name), is considered by Martin & Alexopoulos (1969) as “largely subtropical or tropical”. In Mexico it was found both in tropical zones, in Veracruz in Los Tuxtlas Tropical Biology Station (Lado et al. 2003) and Quintana Roo in El Edén Ecological Reserve (Stephenson et al. 2003), and in temperate regions, in Tlaxcala (Hernández-Cuevas et al. 1991, Rodríguez-Palma 1998).

Dianema corticatum Lister, Monogr. Mycetoza: 205. 1894

FIGURES 5-6

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Cumbres de Majalca, on bark of *Quercus* sp., leg. M. Lizárraga, G. Mendoza, H. Pelayo & P. García, put in moist chamber on 3-III-2004, obtained on 11-III-2004, UACJ 610. *Ibidem*, obtained on 18-III-2004, UACJ 603. *Ibidem*, obtained on 26-III-2004, UACJ 623. *Ibidem*, 6-IV-2004, UACJ 618 in AH 31776.

DESCRIPTION — Fructifications sporocarpic to plasmodiocarpic, sessile, scattered, 0.2-1 mm in diam. Sporotheca flattened to subglobose, with irregular dehiscence. Peridium membranous, hyaline to greyish yellow. Columella absent. Hypothallus membranous, inconspicuous. Capillitium composed of filaments 1-2 μm in diam., attached to base and the upper peridium wall, bearing some swellings. Spores in clusters of 2-9 units, olivaceous in mass, light olivaceous by transmitted light, subglobose to pyriform, 10-12 μm in diam., spiny. Under SEM the spore ornamentation is seen to be formed of baculae.

COMMENTS — Although this species is common in spring in mountainous areas on coniferous wood and coincides sometimes with thawing of snow, it also fructifies in Mediterranean zones on wood of *Pinus halepensis* (Oltra 1995).

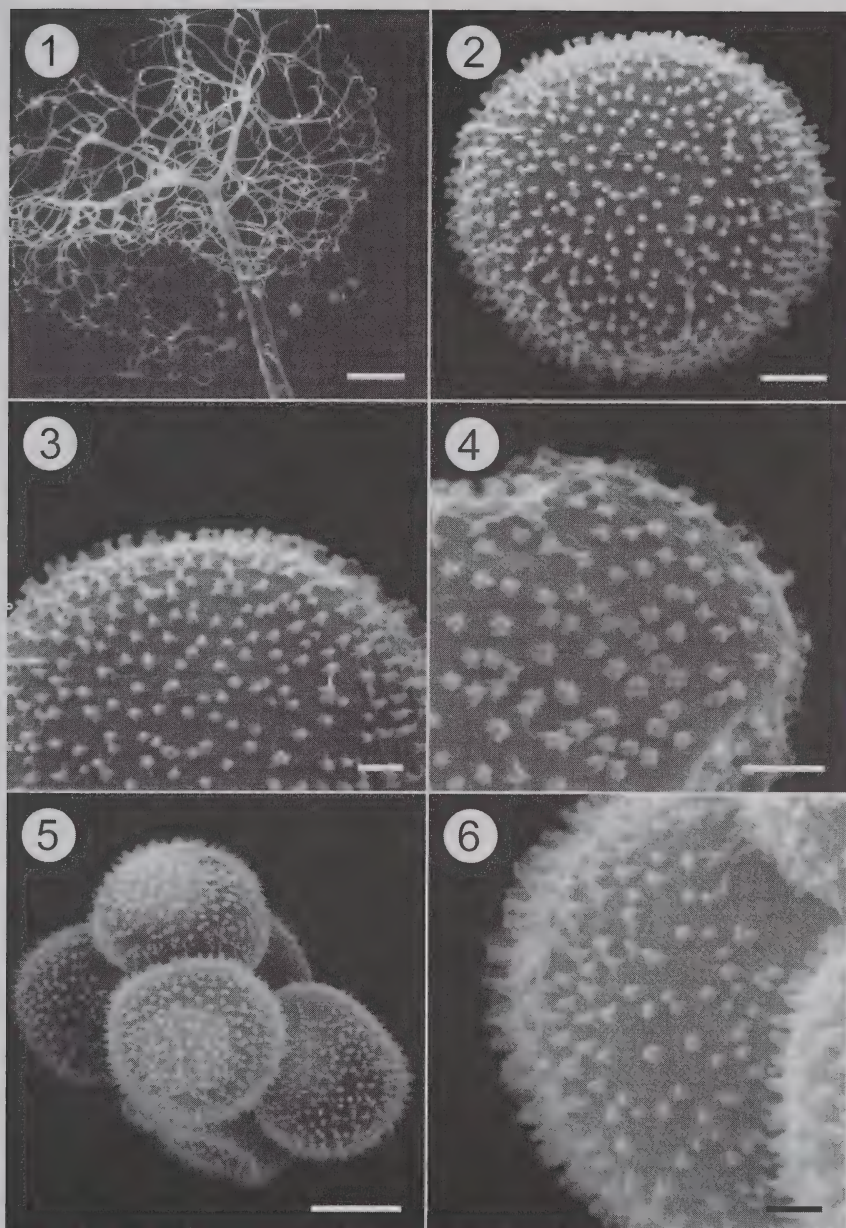
This represents the first record for Mexico. Keller & Braun (1977) cited a species of *Dianema*, “close to *D. corticatum*”, which they identified as *Dianema* sp.

Diderma effusum (Schw.) Morgan, J. Cincinnati Soc. Nat. Hist. 16: 155. 1894

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Rancho “Las Tinajas”, ctra. a Namiquipa km. 15, Chihuahua, on leaves of *Quercus* sp., leg. M. Lizárraga, H. Pelayo, E. Alvarez & L. de la Rosa, 27-VIII-2004, UACJ 674, 684 and 690 in AH 31777. *Ibidem*, M. Lizárraga, D. López & M. Reyes, UACJ 710.

COMMENTS — *Diderma effusum* is characterized macroscopically by its fructifications forming sessile sporocarps to narrow plasmodiocarps with a double peridium, the outer layer being smooth, eggshell-like and the inner one membranous. All the specimens from Chihuahua have broad plasmodiocarps of low height and only the inner layer of the peridium can be observed, as the outer one has been lost. However, remainders at the edge of the fructifications can be observed. On the other hand, the microscopic characters are the same, as all the collections have a delicate, hyaline to slightly violaceous capillitium and light violaceous brown spores, 7-9 μm in diam., seeming almost smooth, with dense warts and darker areas.

The species has been cited from Chiapas (Emoto 1933), Jalisco (Lado et al. 1999), Quintana Roo (Lado et al. 2003, Stephenson et al. 2003) and Veracruz (Lado et al. 2003).



FIGURES 1-5. *Comatrixa elegans* (AH 31773). 1. Detail of the columella (bar = 50 μm). 2. Spore (bar = 2 μm). 3. Detail of spore ornamentation (bar = 1 μm). FIGURE 4. *Comatrixa tenerrima* (UACJ 612). 4. Detail of spore ornamentation (bar = 1 μm). FIGURES 5-6. *Dianema corticatum* (AH 31776). 5. Spore cluster (bar = 5 μm). 6. Detail of spore ornamentation (bar = 1 μm).

Lamproderma gulielmae Meyl., Bull. Soc. Vaud. Sci. Nat. 52: 449. 1919

FIGURES 7-8

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** San Juanito Bocoyna, on leaves of *Quercus crassifolia*, leg. M. Lizárraga & H. Pelayo, 17-IX-2004, UACJ 773 in AH 31778.

COMMENTS — This species from a not strictly nivicolous habitat can be distinguished, apart from its stalked sporocarps with a persistent, iridescent peridium bearing dark spots, by its very dark violaceous and strongly spiny spores. The studied material presents larger spores (15-17 μm in diam.) normally attributed to this species (12-15 μm). The rest of the characters are very similar.

This species can be confused with *Lamproderma maculatum* Kowalski, but the latter has a shorter stalk and a strictly nivicolous habitat.

Only one record is known for the state of Tlaxcala (Rodríguez-Palma 1998).

Macbrideola cornea (G. Lister & Cran) Alexop., Mycologia 59(1): 112. 1967

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Cumbres de Majalca, on bark of *Quercus* sp., leg. M. Lizárraga, G. Mendoza, H. Pelayo & P. García, 15-XI-2003, obtained in moist chamber culture on 12-VI-2004, UACJ 648 in AH 31779.

COMMENTS — This species is characterized by its tiny sporocarps 0.5-0.6 mm high, its globose to subglobose sporotheca 0.1-0.2 mm in diam., its evanescent peridium persisting as a collar, its columella that penetrates 100-110 μm in the sporotheca, its capillitium dichotomously branched at the periphery with terminations 3-5 μm in diam., and by its spores 6-8 μm in diam., globose and warty.

Macbrideola cornea only has been cited previously from Guerrero (Keller & Braun 1977) and from Yucatán (Braun & Keller 1976, Keller & Braun 1977).

Macbrideola synsporos (Alexop.) Alexop., Mycologia 59(1): 115. 1967

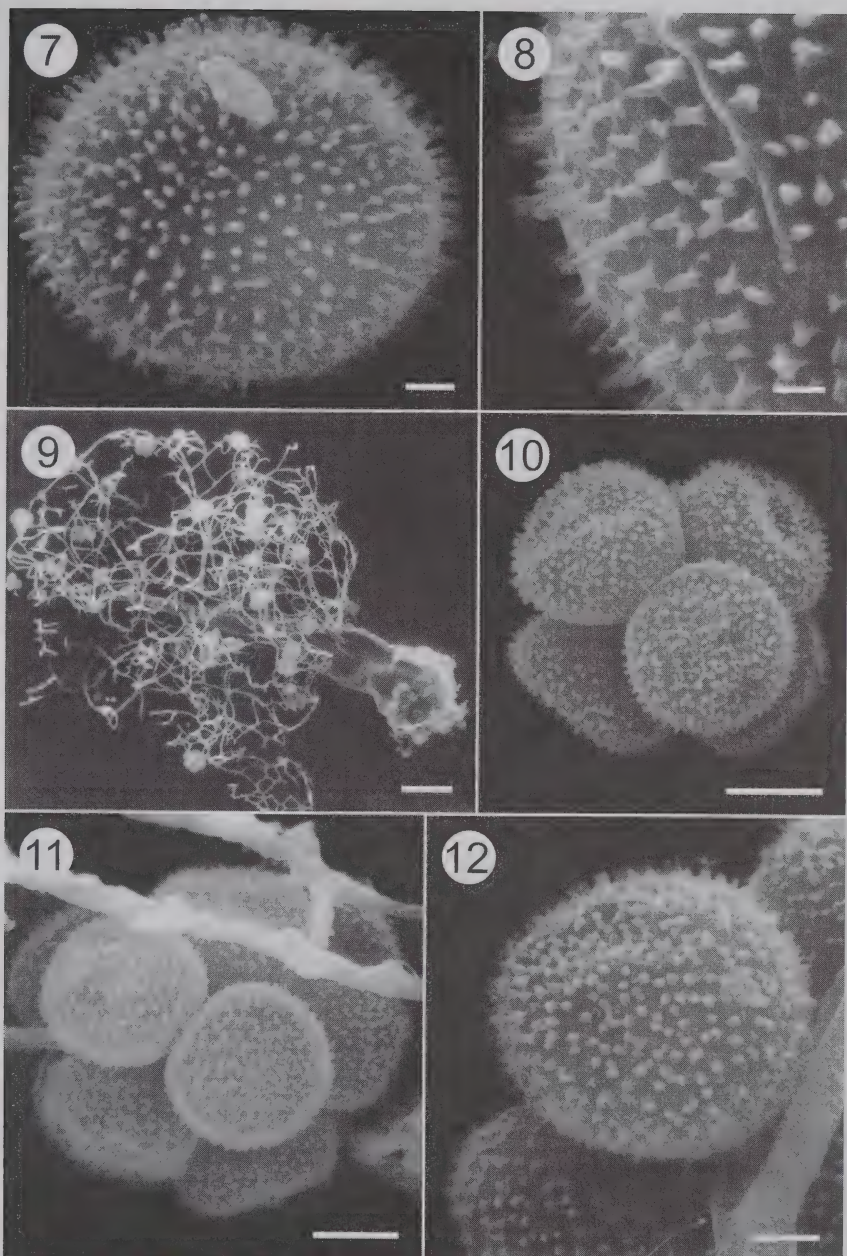
FIGURES 9-12

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** San Bernabé Cusihiaciachi, Cuahutemoc, on bark of *Quercus* sp., leg. E. Orozco, obtained in moist chamber on 07-III-2004, UACJ 576. *Ibidem*, on stems of *Quercus* sp., obtained on 26-II-2004, UACJ 231. *Ibidem*, 2-III-2004, UACJ 620 in AH 31781. *Ibidem*, 04-III-2004, UACJ 575 in AH 31780. *Ibidem*, 8-III-2004, UACJ 612. *Ibidem*, 23-III-2004, UACJ 621. *Ibidem*, 2-IV-2004, UACJ 624. *Ibidem*, 8-III-2004, UACJ 617.

DESCRIPTION — Sporocarps scattered, stalked, 0.4-0.8 mm high. Sporotheca subglobose, 0.3-0.5 in diam. Hypothallus membranous, inconspicuous. Peridium completely evanescent. Stalk brown, lighter at the widened base. Columella reaching half the height of the sporotheca. Capillitium branching, anastomosing, forming a net with a few free ends; threads 1-2 μm in diam., covered by numerous small spines.

Spores brown in mass, light violaceous by transmitted light, in clusters of 4-9 individuals, globose to subglobose, 10-12 μm in diam., spiny. Under SEM spore ornamentation is seen to be formed by dense baculae.

COMMENTS — This record represents the first for Mexico.



FIGURES 7-8. *Lamproderma gulielmae* (AH 31778). 7. Spore (bar = 2 μm). 8. Detail of spore ornamentation (bar = 1 μm). FIGURES 9-12. *Macbrideola synsporos* (AH 31780). 9. Detail of sporocarp (bar = 50 μm). 10-11. Spore clusters (bar = 5 μm). 12. Detail of spore ornamentation (bar = 1 μm).

Perichaena syncarpon T. E. Brooks, Mycologia 38(1): 110. 1946

FIGURES 13-14

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Cumbres de Majalca, on cow dung, *leg.* M. Lizárraga, G. Mendoza, H. Pelayo & P. García, 15-XI-2003, UACJ 644 in AH 31781, 613, 619 in AH 31782 and 622.

DESCRIPTION — Sporocarps sporocarpic to plasmodiocarpic, sessile, in groups to scattered, 0.3-0.5 mm in diam., 1-4 mm long. Sporotheca flattened to subglobose, with irregular dehiscence. Peridium membranous, double, with the outer layer yellowish to ocraceous yellowish and the inner layer hyaline, strongly united to the outer layer. Columella absent. Hypothallus membranous, inconspicuous. Capillitium scarce, formed by a net of hollow tubes 3-6 μm in diam., attached to the peridium, yellow. Spores golden yellow in mass, yellow in transmitted light, grouped in clusters of 4-12 spores, globose, subglobose to oval, 10-12 μm in diam., spiny. Under SEM spore ornamentation is seen to be formed by pilae.

COMMENTS — The material examined agrees closely with the description given by Brooks (1946). Although this species was first described as growing on leaves, *Perichaena syncarpon* was later considered a coprophilous species (Eliasson & Lundqvist 1979, Eliasson & Keller 1999).

Rammeloo (1984) studied type material of Brooks and enclosed in the packet SEM photographs of the inner side of the peridium and of the spore ornamentation. The foliicolous specimens studied by him present pilae with the upper part little developed, whereas the specimens from Chihuahua present pilae with a broader upper part.

According to our information, after the records of Brooks (1946) from USA (Kansas) and Eliasson & Lundqvist (1979) from Tanzania, the collections from Chihuahua represent the third record worldwide and the first one for Mexico.

Physarum cinereum (Batsch) Pers., Neues Mag. Bot. 1: 89. 1794

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Rancho "Las Tinajas", ctra. a Namiquipa km. 15, Chihuahua, on leaves of *Quercus* sp., *leg.* M. Lizárraga, H. Pelayo, E. Alvarez & L. de la Rosa. 27-VIII-2004, UACJ 698, 701 and 705.

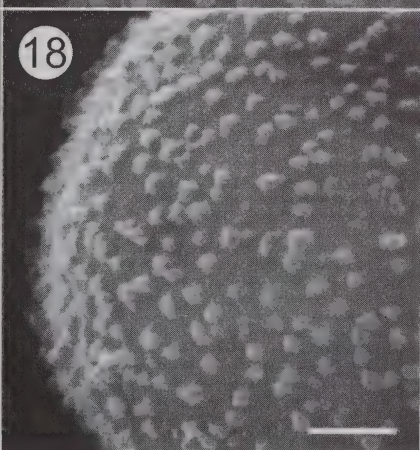
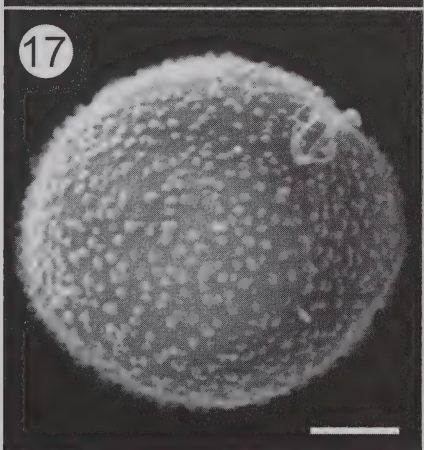
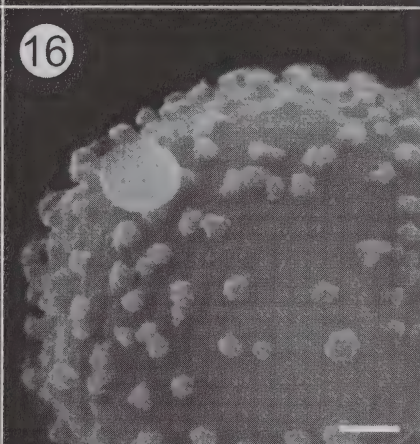
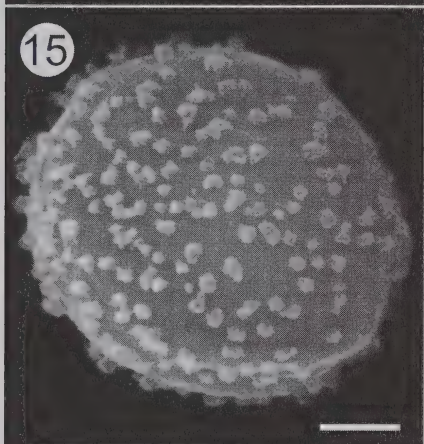
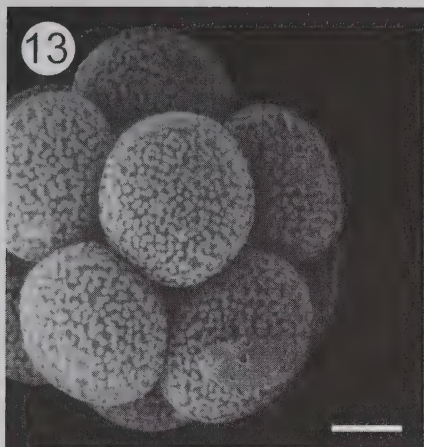
COMMENTS — Although this is a much cited species in Mexico (Illana et al. 2000), our collections of *Physarum cinereum* represent the first record for Chihuahua.

Physarum didermoides (Pers.) Rostaf., Sluzowce Monogr.: 97. 1874

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Cumbres de Majalca, on *Agave* sp., *leg.* M. Lizárraga, G. Mendoza, H. Pelayo & P. García, 15-XI-2003, UACJ 494, 508 and 512.

COMMENTS — This is a much-cited species in Mexico (Illana et al. 2000), not previously registered from Chihuahua.

FIGURES 13-14. *Perichaena syncarpon* (AH 31781). 13 Spore cluster (bar = 5 μm). 14. Spore (bar = 2 μm). **FIGURES 15-16.** *Physarum newtonii* (AH 31784). 15. Spore (bar = 2 μm). 16. Detail of spore ornamentation (bar = 1 μm). **FIGURES 17-18.** *Craterium paraguayense* (AH 31775). 17. Spore (bar = 2 μm). 18. Detail of spore ornamentation (bar = 1 μm).



Physarum newtonii T. Macbr., Bull. Iowa Univ. Lab. Nat. Hist. 2: 390. 1893

FIGURES 15-16

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: San Juanito Bocoyna, on leaves of *Quercus* sp., leg. M. Lizárraga & H. Pelayo, 17-IX-2004, UACJ 748 and 749 in AH 31784.

DESCRIPTION — Sporocarps stalked, solitary or in groups, 0.8-1.2 mm high. Sporotheca globose to subglobose, 0.5-0.8 mm in diam. Peridium single, membranous, calcareous, violaceous. Stalk dark reddish, longitudinally striate, 0.3-0.6 mm high. Hypothallus dark, membranous. Capillitium formed by angular, calcareous nodes with more or less dark violaceous tones, interconnected by hyaline filaments. Spores black in mass, dark violaceous by transmitted light, with a clearer area, globose to subglobose, 10-11(13) μ m in diam., with thick warts. Under SEM spore ornamentation is shown to be formed by irregularly distributed thick baculae.

COMMENTS — The differences between this species and *Craterium paraguayense* have been discussed above. This record of *Physarum newtonii* is the first for Mexico.

Symphytocarpus amaurochaetoides Nann.-Bremek. in Ing & Nannenga-Bremekamp, Proc. Kon. Ned. Akad. Wetensch., C. 70(2): 220. 1967

FIGURES 19-20

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: San Juanito Bocoyna, on wood of *Pinus arizonica*, leg. M. Lizárraga & H. Pelayo, 17-IX-2004, UACJ 776 in AH 31785.

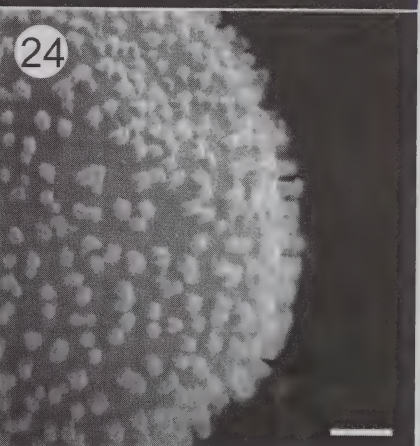
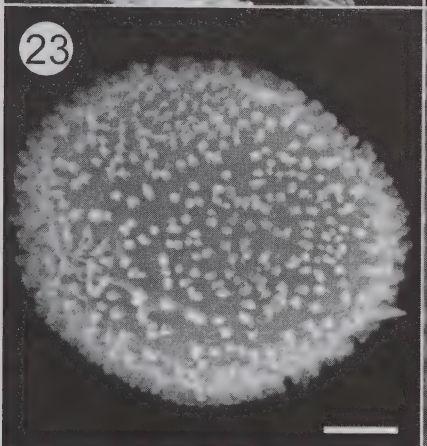
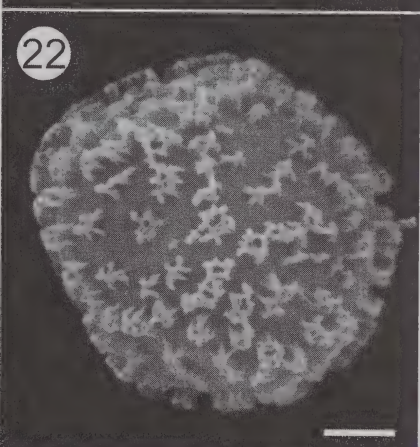
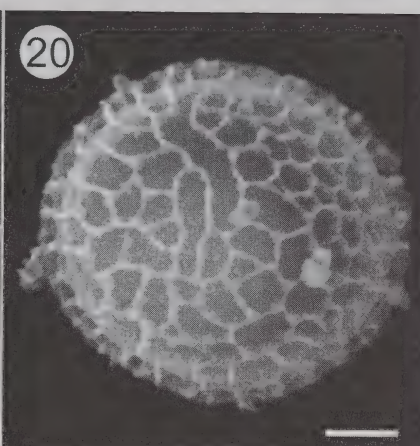
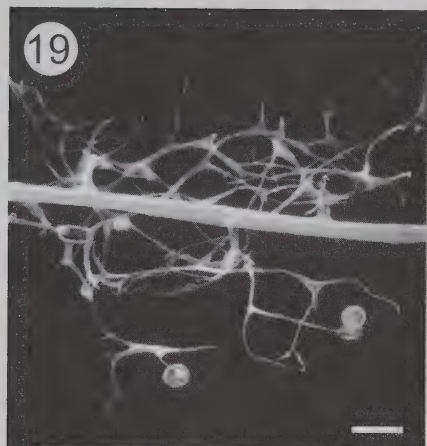
COMMENTS — *Symphytocarpus amaurochaetoides* is characterized macroscopically by its fructifications in the form of dark violaceous pseudoaethalia up to 3 x 2 cm. The spores are globose to subglobose, 7-8 μ m in diam. and bear a reticulate ornamentation. Under SEM the spores show a typical reticulate ornamentation with horizontally perforated muri with irregular lumina, reminding us of the ornamentation of *Stemonitis fusca* Roth. *Symphytocarpus amaurochaetoides* and *Stemonitis fusca* can easily be distinguished microscopically, because the capillitium of the former species has free ends and does not form a surface net typical of the genus *Stemonitis*.

This is the first record for Mexico.

Trichia agaves (G. Moreno, Lizárraga & Illana) Mosquera, Lado, Estrada & Beltrán-Tej., Nomenmyx A nomenclatural taxabase of Myxomycetes : 82. 2001
= *Trichia perichaenoides* Mosquera, Lado, Estrada & Beltrán-Tej., Mycotaxon 75: 320. 2000

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Basaseachic, Ocampo, on dry leaves of *Agave* sp., leg. M. Lizárraga & H. Pelayo, 23-V-2004, UACJ 654.

FIGURES 19-20. *Symphytocarpus amaurochaetoides* (AH 31785). 19. Detail of the capillitium (bar = 20 μ m). 20. Spore (bar = 2 μ m). **FIGURES 21-22.** *Trichia decipiens* var. *olivacea* (AH 31786). 21. Detail of elaters (bar = 5 μ m). 22. Spore (bar = 2 μ m). **FIGURES 23-24.** *Willkommlangea reticulata* (UACJ 656). 23. Spore (bar = 2 μ m). 24. Detail of spore ornamentation (bar = 1 μ m).



COMMENTS — *Trichia agaves* is a species that is ecologically associated with crassulaceous plants (*Opuntia*, *Agave*), recently described from Mexico (Moreno et al. 2000) and also found in Peninsular Spain and the Canary Islands.

It is macroscopically similar to *Perichaena corticalis* (Batsch) Rostaf., but differs clearly by its capillitium formed of elaters ornamented with spines. In some specimens we have observed “hemitrichioid” forms where free ends can hardly be observed.

Trichia decipiens* var. *olivacea (Meyl.) Meyl., Bull. Soc. Vaud. Sci. Nat. 55: 244.

1924

FIGURES 21-22

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Basaseachic, Ocampo, on decomposing wood, leg. M. Lizárraga & H. Pelayo, 9-X-2004, UACJ 781 in AH 31786 and 782.

COMMENTS — This variety of *Trichia decipiens* is characterized by its stalked sporocarps with a stalk filled with cysts. Microscopically it is defined by its elaters ornamented by smooth spiral bands, with long points. The spores are smaller than indicated in the literature, 9-10 μm in diam., ornamented by small crests that do form a closed reticulum. Under SEM spore ornamentation is seen to be composed of small crests formed by coalescent baculae.

Trichia decipiens appears much cited in Mexico, mainly in the centre of the country (Illana et al. 2000). This is the first record of *Trichia decipiens* var. *olivacea* for Mexico.

Trichia varia (Pers. ex J.F. Gmel.) Pers., Neues Mag. Bot. 1: 90. 1794

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Basaseachic, Ocampo, on decomposing wood, leg. M. Lizárraga & H. Pelayo, 9-X-2004, UACJ 804, 805, 812 and 819. *Ibidem*, on dead leaves of *Agave* sp., 779, 780. *Ibidem*, on stems of *Quercus* sp., UACJ 801.

COMMENTS — This cosmopolitan species in Mexico is only known from the states of Baja California (Lizárraga et al. 2004), Jalisco (Trujillo-Flores et al. 1986) and Veracruz (Braun & Keller 1976).

Willkommlangea reticulata (Alb. & Schwein.) Kuntze, Revis. Gen. Pl. 2: 875.

1891

FIGURES 23-24

SPECIMENS EXAMINED — **MEXICO. CHIHUAHUA:** Basaseachic, Ocampo, on bark of *Quercus crassifolia*, leg. M. Lizárraga & H. Pelayo, 3-VIII-2004, UACJ 656.

COMMENTS — This species is characterized macroscopically by its sessile reticulate plasmodiocarps. Spore ornamentation under SEM is seen as formed by tight, regularly distributed spines.

This species has only has been cited in Mexico from the states of Jalisco (Trujillo-Flores et al. 1986), Nuevo León (Gómez-Sánchez & Castillo 1981) and Quintana-Roo (Lado et al. 2003, Stephenson et al. 2003).

Acknowledgements

Investigation has been partly financed by the Research Project “Programa del Mejoramiento del Profesorado, Secretaría de Educación Pública, México (PROMEP-SEP), P/PROMEP: UACDJ-PTC-02-01” and the Research Project of the “Ministerio de Ciencia y Tecnología, Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica, España, REN2002-01965”. We express our gratitude to Dr. R.P. Korf, Mr. D.W. Mitchell and Mr. H. Müller for the revision of the manuscript, Dr. H. Pelayo and Mr. E. Orozco (Univ. Autónoma Ciudad Juárez) for their help with the field work and we wish to thank Mr. J.A. Pérez and Mr. A. Priego from the “Servicio de Microscopía Electrónica, Universidad de Alcalá” for their invaluable help with the SEM.

Literature Cited

- Braun KL, Keller HW. 1976. *Myxomycetes* of Mexico. I. Mycotaxon 3: 297-317.
- Brooks TE. 1946. A new species of *Myxomycetes*. Mycologia 38: 110-112.
- Castillo A, Moreno G, Illana C, Singer H. 2002. Notes on two violet species belonging to *Physarales* (*Myxomycetes*). Mycotaxon 82: 347-356.
- Eliasson U, Lundqvist N. 1979. Fimicolous myxomycetes. Bot. Notiser 132: 551-568.
- Emoto Y. 1933. Myxomyceten aus Mexiko. Bot. Mag. (Tokyo) 47: 132-135.
- Eliasson U, Keller HW. 1999. Coprophilous myxomycetes: updated summary, key to species, and taxonomic observations on *Trichia brunnea*, *Arcyria elaterensis* and *Arcyria stipata*. Karstenia 39: 1-10.
- Gómez-Sánchez A, Castillo J. 1981. Estudio sobre los *Myxomycetes* del estado de Nuevo León. Bol. Soc. Mex. Micol. 15: 199-223.
- Hernández-Cuevas L., Estrada-Torres A. 1993. El género *Badhamia* en el estado de Tlaxcala. XII Congreso Mexicano de Botánica, Libro de resúmenes: 125. Mérida, Yucatán.
- Hernández-Cuevas L., Rodríguez-Palma M., Galindo-Flores G., Estrada-Torres A. 1991. New records of *Myxomycetes* from Mexico. Mycotaxon 62: 17-27.
- Illana C, Moreno G, Lizárraga M. 2000. Catálogo de *Myxomycetes* de México. Stapfia 73: 167-186.
- Keller HW, Braun KL. 1977. *Myxomycetes* of Mexico. II. Bol. Soc. Méx. Micol. 11: 167-180.
- Lado C, Rodríguez-Palma M, Estrada-Torres A. 1999. *Myxomycetes* from a seasonal tropical forest on the Pacific coast of Mexico. Mycotaxon 61: 307-321.
- Lado C, Estrada-Torres A, Stephenson SL, Wrigley de Basanta D, Schnittler M. 2003. Biodiversity assessment of *Myxomycetes* from two tropical forest reserves in Mexico. Fungal Diversity 12: 67-110.
- Lister A. 1925. A Monograph of the Mycetozoa, a descriptive catalogue of the species in the herbarium of the British Museum. 3 ed. revised by G. Lister. Printed by order of the Trustees of the British Museum. London.
- Lizárraga M, Moreno G, Illana C. 1997. The *Myxomycetes* from Baja California (Mexico). I. Mycotaxon 63: 287-300.
- Lizárraga M, Illana C, Moreno G. 2004. Contribución al estudio de los *Myxomycetes* de la Península de Baja California, México. Bol. Soc. Micol. Madrid 28: 43-53.
- Lizárraga, M, Moreno G, Illana C. 2005. *Myxomycetes* from Chihuahua, Mexico. II. Österr. Z. Pilzk., sent for publication.
- Lizárraga M, Moreno G, Singer H, Illana C. 2003. *Myxomycetes* from Chihuahua, México. Micol. Veg. Medit. 13: 167-176.

- Martin GW, Alexopoulos CJ. 1969. The *Myxomycetes*. University of Iowa Press. Iowa City. 561 pp.
- Mitchell DW. 2004. A key to corticolous *Myxomycetes*. Syst. Geogr. Pl. 74: 261-285.
- Moreno G, Illana C, Lizárraga M. 2001. SEM studies of the *Myxomycetes* from the Peninsula of Baja California (Mexico), III. Additions. Ann. Bot. Fennici 38: 225-247.
- Moreno G, Sánchez A, Singer H, Illana C, Castillo A. 2002. A study on nivicolous *Myxomycetes*. The genus *Lamproderma* I. Fungi non Deliniati 19: 1-66.
- Moreno G, Lizárraga M, Illana C, Castillo A, Oltra M. 2000. *Hemitrichia agaves* sp. nov. un nuovo *Myxomycete* delle piante grasse dal Messico e dalla Spagna. Rivista di Micologia. Boll. Assoc. Micol. Bresadola 1: 5-16.
- Oltra M. 1995. Contribución al conocimiento de los *Myxomycetes* de la provincia de Valencia (España) y zonas limítrofes. II. Bol. Soc. Micol. Madrid 20: 71-84.
- Rammeloo J. 1983. *Echinosteliales* et *Stemonitales* (*Myxomycetes*). In: Flore illustrée des champignons d'Afrique Centrale, fascicule 11: 214-244. Ministère de l'Agriculture, Jardin Botanique National Belgique, Meise.
- Rammeloo J. 1984. Icones Mycologicae 60. Jardin Botanique National Belgique, Domaine de Bouchout. B- 1869 Meise.
- Rodríguez-Palma M. 1998. *Myxomycetes* of the State of Tlaxcala. McIlvainea 13: 25-32.
- Stephenson SL, Estrada-Torres A, Schnittler M, Lado C, Wrigley de Basanta D, Ogata N. 2003. Distribution and ecology of *Myxomycetes* in the forests of Yucatán. In: Gómez-Pompa A, Allen MF, Fedick SL, Jiménez-Osorio JJ (eds.): The Lowland Maya Area: Three Millennia at the Human-Wildland Interface, 241-269. Haworth Press. New York.
- Trujillo-Flores F, Castañeda Macías M, Guzmán-Dávalos L. 1986. Hongos del estado de Jalisco, VI. Los *myxomycetes* conocidos. Tiempos de Ciencia 5: 42-51.

A new species of *Morchella* (Pezizales, Ascomycota) from southwestern China

Ji-YUE CHEN¹ & PEI-GUI LIU^{*2}

¹chenjiyue@mail.kib.ac.cn ²pgliu@mail.kib.ac.cn

Kunming Institute of Botany, Academia Sinica

Kunming 650204, P.R. China

Abstract—A new species of *Morchella*, *M. bicostata*, is described from southwestern China. This species is characterized by reddish-brown to flesh-colored hymenia and tortuous, bicostate ribs. Its gross morphology and microscopic features are illustrated by photographs and line drawings.

Key words—morel, taxonomy

Introduction

Morels (*Morchella* spp.) are among the most expensive wild edible fungi in the world. Fifteen species of *Morchella* have been reported in China (Zang 1987, Mao 2000), including five species from southwestern China (Zang 1987, Ying & Zang 1994). In our recent studies on the genus, 145 specimens were examined from southwestern China. Among these was found a new species described herein as *M. bicostata*. This species differs from all known species of the genus in that the macro- and microscopic features of this fungus are distinct (Eckblad 1968, Guzmán & Tapia 1998).

Material and Methods

Field notes were taken for gross morphology of fresh ascomata. Microscopic examination of ascomata and measurements of microscopic structures were made from freehand sections mounted in 5% aqueous KOH, Melzer's reagent, Cotton-blue lactophenol, or in Congo-red. Cultures were not obtained from the dried specimens. Line drawings were made with the aid of a microscopic drawing tube. All specimens, including the holotype of *Morchella bicostata* cited in this paper, have been deposited in the Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica (HKAS).

Taxonomy

Morchella bicostata J.Y. Chen & P.G. Liu, sp. nov.

Fig. 1-7

Ascomata (30-) 35-45 (-50) mm alta, intus excavata. Capitulae (15-) 20-25 (-30) × (10-) 13-15 (-20) mm, subconicae vel subcylindrico-ovoideae, basi stipiti adnatae,

* Corresponding author

rubiginosae vel carneae, superficialiter costis numeroeis neticulatis irregulariter tortuosis, bicostis, maculis inter costae rotundatis vel polygonis. Stipites 10-20 × 7-12 mm, pallidi vel cremei, cylindricis, sulcati vel rugosi, interdum basi inflati, superficialiter appendicibus faveolatis instructi. Asci (230-) 250-270 (-320) × 18-25 μm, subcylindracei vel cylindrici operculati, octospori. Ascospores (18-) 22-24 (-26) × (11.5-) 12.5-13 (-16) μm, hyalinae, late ellipsoideae vel ovoideae, inamyloideae. Paraphyses (110-) 130-180 (-250) × 10-16 μm, cylindratae, basi septatae et ramosae, hyalinae.

Habitat in terribus in Abitibus spp. sylvis. Holotypus hic designatus HKAS 31285.

Etymology—From latin *bicosta*, bi- = double, costa = ribs, referring to pileus of the fruitbody with bicostate ribs which have a shallow groove down the center.

Ascomata (30-) 35-45 (-50) mm high, hollow, pileus adnate stipitate; pileus (15-) 20-25 (-30) × (10-) 13-15 (-20) mm, subconic to subcylindric-ovoid, ribs tortuous and bicostate, with a shallow groove running down the center; pits round to polygonal; pileus reddish-brown to flesh-colored when fresh, pale gray or grayish brown to black-brown and ribs more or less lighter than pits when dry; stipe 10-20 × 5-9 mm, cylindric, enlarged at its base, up to 12 mm wide, whitish to cream when fresh, honey-yellow to ochre when dry, furfuraceous-granular, lightly to strongly wrinkled at base; asci (230-) 250-270 (-320) × 18-25 μm, operculate, subcylindric or cylindric, some with a sub-bulbous base, 8-spored, hyaline; ascospores (18-) 22-24 (-26) × (11.5-) 12.5-13 (-16) μm, broadly elliptical to ovoid, thick-walled, with fine granulate striations on surface, hyaline and non-amyloid; paraphyses (110-) 130-180 (-250) × 10-16 μm, cylindrical, septate and branched near base, hyaline; flesh of pileus composed of hyaline, interwoven and septate hyphae, 5-14 μm wide, inner surface cells globose, subglobose or clavate; surface of stipe composed of large inflated cells, inner cells the same as the pileus.



Fig 1. (A) Habitat of *Morchella bicostata*, HKAS 31285 (holotype!). (B) Arrow indicates bicostate rib.

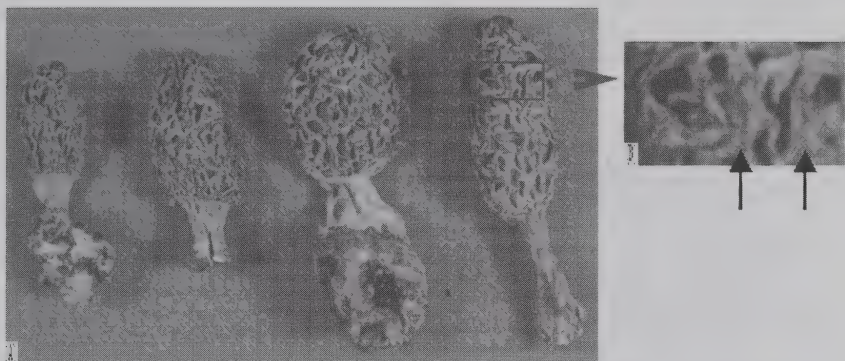


Fig 2. (A) Dry ascocarps of *Morchella bicostata*, HKAS 31285 (holotype!). (B) Arrows indicate bicostate ribs.

Specimen examined—Shuajing road crossing Shuajingsi village, Hongyuan County, Sichuan Province, China, alt. 3600m, on the ground under *Abies* spp., 14 May 1997, M.S. Yuan 2780, HKAS 31285 (Holotype!), labeled as *M. esculenta* (L.) Pers.

Notes—*M. bicostata* differs from all described species of the genus in its reddish-brown to flesh-colored pileus with tortuous, bicostate ribs. It is different from the morphologically similar species, *M. esculenta* (L.) Pers., in the shape and color of the pileus and the arrangement of its ribs and pits. *M. esculenta* possesses a subglobose, ovoid, or elongated pileus with rounded, irregular or occasionally longitudinally elongate pits which are yellowish within, becoming brownish or blackish when dry. In addition, its ribs are single with rounded edges that are lighter colored than the interior of the pits (Seaver 1928). *M. bicostata* is morphologically similar to *M. crispa* P. Karst.; however, the latter species produces compact, tortuous ribs and a sandy beige or buff pileus (Karsten 1887, Saccardo 1889).

Acknowledgements

The authors would like to thank Profs. M. Zang and Z. L. Yang (Kunming Institute of Botany, Academia Sinica) for their valuable suggestions and discussion. They also give thanks to Prof. and Dr. W.Y. Zhuang (Institute of Microbiology, Academia Sinica) and Dr. Kerry O'Donnell (NCAUR, ARS, USDA) for serving as pre-submission reviewers, Prof. Z. Y. Su (Kunming Institute of Botany, Academia Sinica) for checking the Latin description, and Mr. M. S. Yuan (Chengdu Institute of Biology, Academia Sinica) for providing the photographs used in this study. This study was supported in part by the National Natural Science Foundation of China (No. 30470011), the Knowledge Innovation Program of the Chinese Academy of Sciences Project (No. KSCX2-SW-101C; KSCX2-1-09-06), and the Natural Science Foundation of Yunnan (No. 2004C0050M).

Literature Cited

- Eckblad F-E. 1968. The genera of operculate Discomycetes. *Nytt Mag. Bot.* 15: 1-191.
 Guzmán G, Tapia F. 1998. The known morels in Mexico, a description of a new blushing species, *Morchella rufobrunnea*, and new data on *M. guatemalensis*. *Mycologia* 90: 705-714.

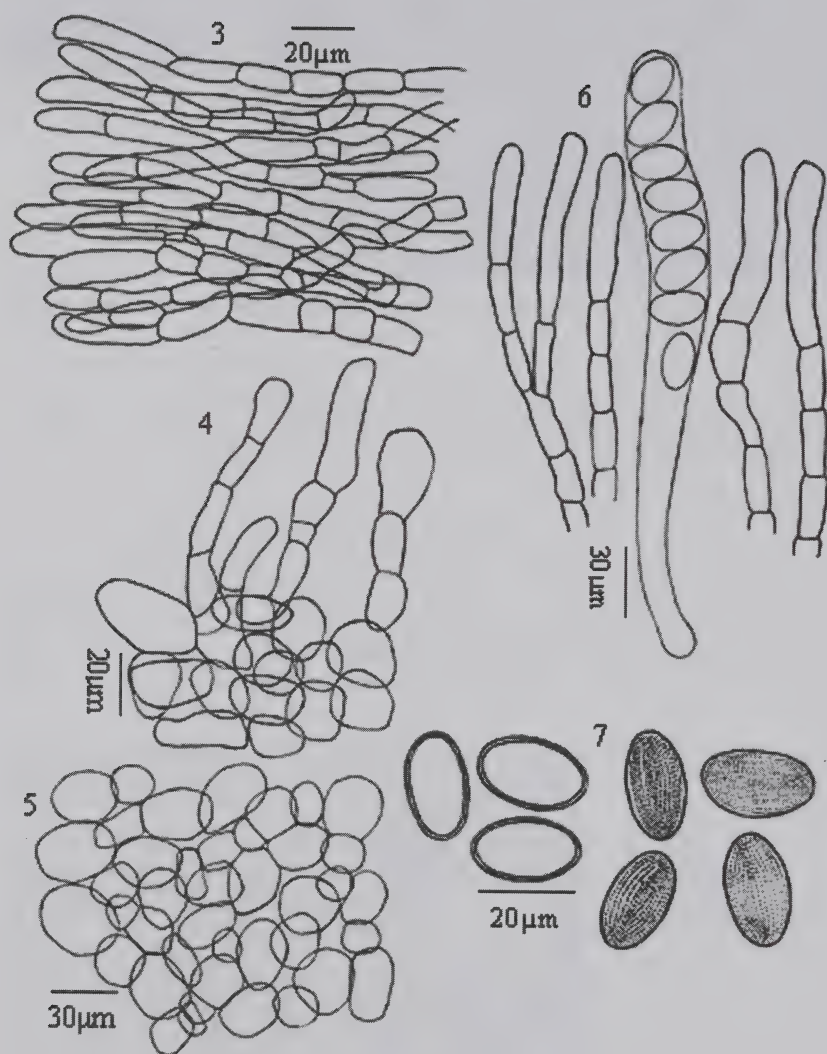


Fig 3-7. Microscopic features of *Morchella bicostata*, HKAS 31285 (holotype!) 3. Region adjacent to the hymenium composed of *textura intricata*; 4. Free chains of inflated cells on stipe inner surface; 5. Stipe surface composed of *textura angularis*; 6. Paraphyses and asci; 7. Ascospores.

- Karsten P. 1887. Fungi Turkest. Hedwigia 3: 112.
- Mao XL. 2000. The Macrofungi in China. Henan Science and Technology Press, Zhengzhou. 1-719.
- Saccardo PA. 1889. Sylloge Fungorum. 8: 1-1143. Padova.
- Seaver F.J. 1928. The North American cup-fungi (Operculates). New York. 1-284.
- Ying JZ, Zang M. 1994. Economic macrofungi from southwestern China. Science Press, Beijing. 1-399.
- Zang M. 1987. Some new and noteworthy higher fungi from eastern Himalayas. Acta Botanica Yunnanica 9(1): 81-88.

中国西南发现的羊肚菌一新种

陈吉岳 刘培贵

中国科学院昆明植物研究所, 昆明 650204, 中国

中文摘要 本文报道了采自中国四川省的羊肚菌一新种—双脉羊肚菌 *Morchella bicostata*, 其鉴别特征为: 头部红棕色到肉红色, 具有扭曲、不规则、双脉络的棱纹。文中提供了其宏观鉴别特征彩图和显微特征线条图。

关键词 双脉羊肚菌 新种 分类

A new species of *Psilocybe* (*Agaricales*, *Strophariaceae*) from southern Brazil

GASTÓN GUZMÁN

guzmang@ecologia.edu.mx

Instituto de Ecología

Apartado Postal 63

Xalapa 91000, Veracruz, MEXICO

VAGNER GULARTE CORTEZ

cortezvg@yahoo.com.br

Universidade Federal do Rio Grande do Sul

Programa de Pós-graduação em Botânica

Av. Bento Gonçalves, 9500, Campus do Vale

CEP: 91501-970 Porto Alegre, RS, BRAZIL

Abstract— *Psilocybe rickii* is described as a new species from Rio Grande do Sul, Brazil. It belongs to the section *Cordisporae* and is characterized by the bulbous base of the stipe. The holotype was collected in 1908 by Rick.

Key words— Basidiomycota, hallucinogenic fungi, neotropical mycobiota

Introduction

In spite of recent studies on the genus *Psilocybe* (Fr.) P. Kumm. in southern Brazil (Guzmán & Cortez 2004; Cortez & Coelho 2004), an undescribed species was surprisingly found among the fungi collected by Johannes Rick. Several collections of *Psilocybe* by Rick were studied by Guzmán (1978, 1983) during his studies on the genus. The collection Fungi Rickiani is mainly deposited in the herbarium PACA (Instituto Anchietano de Pesquisas, São Leopoldo, Rio Grande do Sul, Brazil), but some specimens are deposited in North American and European herbaria (Fidalgo 1962). This paper deals with the description of another probable hallucinogenic fungus, a new species of *Psilocybe* collected by Rick in 1908, recently found in the Farlow Herbarium.

Materials and methods

Microscopic observations were made from sections mounted in 5% KOH solution, previously treated with ethanol for rehydration.

Description of the new species

Psilocybe rickii Guzmán & Cortez, sp. nov.

FIGURES 1-4

Pileus circa 38 mm latus in sicco, convexo subumbonatus, pallide brunneolus, irregulariter atrovinaceo-rufescens, glaber. *Lamellae* subadnatae, cinnamomeae. *Stipes* circa 50 x 4 mm in sicco, rubrobrunneus, fibrosus, base pseudorhizali, bulbosa, cylindrico-pyriformi, usque ad 15-8 mm, albida. *Basidiosporae* 8-10 x 6-8 (-8.5) x (5-) 5.5-7 μ m, in aspectu frontali oblongo-subrhomboideae, in aspectu obliquo subellipsoideae, crassitunicatae, luteobrunneae. *Cheilocystidia* 11-24 x 5-7.5 μ m, hyalina, sublageniformia. *Pileipellis* subgelatinosa. In terra arenacea. Brazil, Rio Grande do Sul, São Leopoldo, 1908. Holotypus hic designatus: Rick 52 (FH).

Pileus about 38 mm diam. as dried, convex subumbonate, pale brownish, irregularly staining dark vinaceous reddish, smooth, possibly subviscid. *Lamellae* subadnate, cinnamon brown, with concolorous edges. *Stipe* about 50 x 4 mm as dried, including the pseudorrhizal bulbous base, this base measures 15 x 8 mm and is cylindrical-pyriform, the remaining stem is cylindrical and uniform, reddish brown, fibrous, the pseudorrhizal base is whitish.

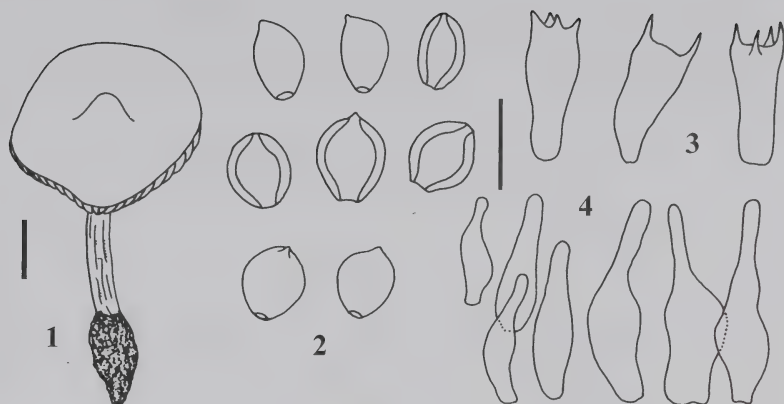
Basidiospores 8-10 x 6-8 (-8.5) x (5-) 5.5-7 μ m, oblong-subrhomboid in face-view, subellipsoid in side-view, thick-walled, yellowish brown, with a distinct and broad germ pore on one end and a short apical appendage on the other. *Basidia* 13-18 x 6.5-7.5 μ m, (2-)4-spored, hyaline, pyriform or subventricose. *Pleurocystidia* not observed (present?). *Cheilocystidia* 11-24 x 5-7.5 μ m, hyaline, regularly or irregularly sublageniform, with a broad or narrow base. *Subhymenium* not differentiated. *Hymenophoral trama* regular, with hyaline hyphae 4-15 μ m wide. *Pileipellis* subgelatinous, 15-25 μ m thick, with hyaline hyphae 1.5-3 μ m wide. *Subpellis* (hypodermium) collapsed. *Context* collapsed. *Stipitipellis* with yellowish prostrate hyphae. *Mycelium* in the bulbous base with hyaline hyphae, but yellowish in mass, 2-4 μ m wide. *Clamp connections* present.

Habitat and distribution: On sandy soil, probably solitary. Known only from the type locality.

Material examined: BRAZIL. Rio Grande do Sul State: São Leopoldo, 1908, Rick 52 (Herbarium F. Theissen at FH, without number, as *Psilocybe shafferi* Rick, *nomen nudum*, holotype).

Discussion: Because of its dark vinaceous tones when dried, this fungus is considered to be caerulescent. Dried specimens of *P. caerulescens* Murrill and *P. wrightii* Guzmán, both bluing fungi, are often similarly dark vinaceous, but not blue as dried. The hypogeous bulbous base of the stipe and the oblong-subrhomboid, thick-walled basidiospores are the main taxonomic features of *P. rickii*. For the form and structure of its basidiospores and its probable bluing feature, this fungus belongs to section *Cordisporae* Guzmán, where all the species belong to the hallucinogenic fungi, following the concept of Guzmán (1983, 1995).

Psilocybe rickii is related to *P. guatapensis* Guzmán et al. from Colombia (Guzmán et al. 1994) by the subbulbous base, but that species has shorter basidiospores [(5.5-) 6-6.5



Figures 1-4. *Psilocybe rickii* (holotype). 1) Basidioma. 2) Basidiospores. 3) Basidia. 4) Cheilocystidia. Scale bars: 10 mm for 1, 10 μm for 2-4.

(-7) μm long] and a conic to acute-campanulate pileus. The absence of pleurocystidia in *P. rickii* is doubtful, because these structures were probably not observed because tissues of the basidioma studied were collapsed

This new species is named in honor of the Priest Johannes Rick, considered the “Father of Brazilian Mycology” and who collected the specimen studied, for his long and important work on fungi from the State of Rio Grande do Sul in Brazil.

With the discovery of this new species, there are now 30 known species of *Psilocybe* in Brazil, 19 of which belong to the hallucinogenic group.

Acknowledgements

The senior author is grateful to CONACYT, SNI and Instituto de Ecología, all Mexican institutions, for the support to his research. He also thanks Etelvina Gándara for her help in the microscopic observations, as well as Manuel Hernández and Juan Lara for their help in computation and the herbarium, respectively. Thanks are given to the Farlow Herbarium for loan of the studied material. The authors thank the reviewers of the present paper, Dr. James Trappe and Dr. Clark L. Ovrebo.

Literature cited

- Cortez VG, Coelho G. 2004. The *Stropharioideae* (*Strophariaceae*, *Agaricales*) from Santa Maria, Rio Grande do Sul, Brazil. *Mycotaxon* 89: 355-378.
- Fidalgo O. 1962. Rick, o Pai da Micologia Brasileira. *Rickia* 1: 3-11.
- Guzmán G. 1978. The species of *Psilocybe* known from Central and South America. *Mycotaxon* 7: 225-255.
- Guzmán G. 1983. The genus *Psilocybe*. *Beih. Nova Hedwigia* 74: 1-439.
- Guzmán G. 1995. Supplement to the monograph of the genus *Psilocybe*. In: Petrini O, Horak E. (eds.). *Taxonomic Monographs of Agaricales*. *Bibl. Mycol.* 159: 91-141.

- Guzmán G, Cortez VG. 2004. The neurotropic *Psilocybe* (Fr.) P. Kummer (Agaricales, Strophariaceae) in Brazil: a revision of the known species, the first record of *P. wrightii* and the synonymy of *P. caeruleoannulata*. Int. J. Med. Mushr. 6: 383-388.
- Guzmán G, Saldarriaga Y, Pineda F, García G, Velázquez LF. 1994. New species of *Psilocybe* from Colombia and discussion of the known species. Mycotaxon 51: 225-235.

Some new species and new records of discomycetes in China. XII

WEN-YING ZHUANG

zhuangwy@sun.im.ac.cn

Key Laboratory of Systematic Mycology & Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080 China

Abstract—Collections of the cup-fungi from Qinghai and Xinjiang, China were examined. Among them, *Scutellinia korfiana* is described as new species. Distinctions between the new taxon and its closely related species are discussed. *Aleuria luteonitens* and *Rhodoscypa ovilla* are new records for China. A new combination is made for a previously described *Melastiza* species.

Key words—taxonomy, *Spooneromyces daliensis*

Introduction

In our recent studies on cup-fungi from northwestern China, a few collections of operculate discomycetes from Xinjiang and Qinghai were examined. One new species is found in the genus *Scutellinia* (Cooke) Lambotte, two species in *Aleuria* Fuckel and *Rhodoscypa* Dissing & Sivertsen are recorded for the first time from the country, and a name change for a previously reported fungus is made. More information about discomycetes from the areas may be gathered from scattered literature (Zhao & Mao 1986; Cao et al. 1990a, b; Zhang & Yu 1992; Mao 1998; Zhuang 1998, 2004).

Taxonomy

NEW SPECIES

Scutellinia korfiana W.Y. Zhuang, sp. nov.

Figs. 1-3

Ab Scutellinia cubensi hymeniis aurantio-rufis; pilis latiusculis, 330–800 × 18–35(–41) μm; ascosporis angustis, 16.5–19 × 10.5–11.7(–12.7) μm; ornamentis ascosporarum vadosis et angustis differt.

Apothecia discoid, sessile, 5–10 mm in diam., hymenium surface orange red, receptacle covered with brown hairs; *hairs* arising from inner ectal excipular cells, setaceous, ventricose, with 2–4 rootlets, septate, thick-walled, brown, 330–800 μm long and 18–35(–41) μm wide, walls 3–7 μm thick; *ectal excipulum* of textura angularis, 110–180 μm thick, cells more or less isodiametric, 20–65 μm in diam. or up to 75 ×

50 μm , cell walls subhyaline to pale brown and thickened in the outer cells, subhyaline and thin-walled in the inner cells; *medullary excipulum* of textura intricata, 75–130 μm thick, hyphae subhyaline, 3.8–10 μm wide; *subhymenium* of textura intricata, 25–35 μm thick, hyphae densely interwoven; *hymenium* ca 210–230 μm thick; *asci* 8-spored, subcylindrical, J– in Melzer's reagent, 215–243 $\times$ 13–15 μm wide; *ascospores* ellipsoid with blunt ends, multiguttulate, some containing a de Bary bubble, surface nearly smooth to finely marked, uniseriate, 16.5–19 $\times$ 10.5–11.7 (–12.7) μm , spore ornamentations as very low warts and crests, irregular in shape, and somewhat interconnected under the light microscope, as interconnected warts and crests which are more or less reticulate viewed by SEM, 0.3–0.7(–1) μm wide and 0.2–0.5 μm high; *paraphyses* filiform and enlarged at apex, 5–7 μm wide at apex and 2.5–3 μm below.

Holotype here designated: CHINA. Xinjiang, Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4760, HMAS 83558. Paratype: CHINA. Xinjiang, Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4762, HMAS 83580.

Etymology: The specific epithet refers to Prof. Richard P. Korf for his contribution to fungal taxonomy and nomenclature.

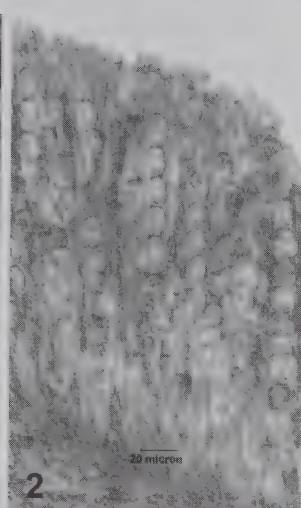
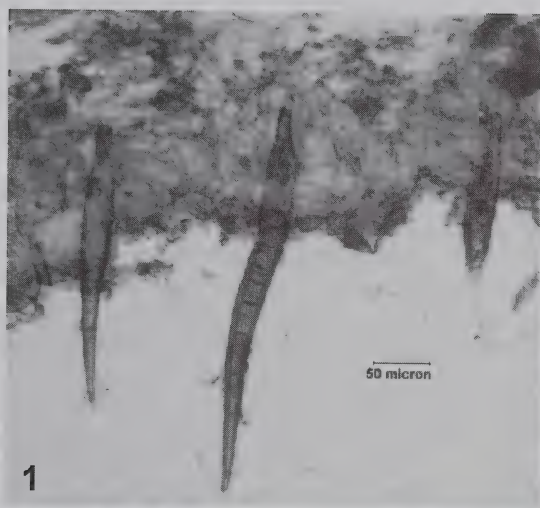
Notes: *Scutellinia korfiana* was found from Hemuxiang in the north of Xinjiang. Among the existing species of the genus, the size of apothecia and shape of ascospore ornamentations of the new species are somewhat similar to those of *S. cubensis* (Berk. & M.A. Curtis) Gamundi, a fungus commonly found in the tropical and subtropical regions (Schumacher 1990); whereas, the very low spore markings under light microscope recalls that of *S. sinosetosa* W.Y. Zhuang & Zheng Wang from Yunnan and Shaanxi provinces (Zhuang & Wang 1998). SEM study of the spore surface morphology of the new species reveals that the spore markings are much narrower and lower than those in *S. cubensis* [0.3–0.7(–1) μm vs. 1–2.2 μm wide and 0.2–0.5 μm vs. 0.3–1.2 μm high] and the ascospores [16.5–19 $\times$ 10.5–11.7(–12.7) μm vs. 15.8–18.5 $\times$ 11.2–14.4 μm] and asci (13–15 μm vs. 15–21 μm wide) are both narrower under light microscope as well. Comparing with *S. sinosetosa*, the spore ornamentations of the new species are much wider.

NEW RECORDS FOR CHINA

Aleuria luteonitens (Berk. & Broome) Gillet, Champignons de France, Les Discomycètes p. 205, 1886.

Diagnostic features: *Apothecia* discoid with a short stalk embedded in soil, 2–2.8 cm in diam., hymenium orange, receptacle paler than hymenium; *ectal excipulum* of textura angularis, 25–43 μm thick; *medullary excipulum* of textura intricata, 230–280 μm thick; *hymenium* 190–200 μm thick; *asci* 8-spored, 7.5–8.5 μm wide; *ascospores* ellipsoid, biguttulate when young, with separate warts on surface, 10.7–12 $\times$ 5–6 μm ; spore markings ca 0.4–0.7 μm in diam. and up to 0.5 μm high; *paraphyses* filiform, straight, 2–4 μm above and 1.5–2 μm below.

Figs. 1–3. *Scutellinia korfiana*: 1. Ectal excipular structure and rooting hairs; 2. Portion of hymenium showing asci and ascospores; 3. Ascospore surface morphology in SEM study. All from holotype.



Specimen examined: China. Qinghai, Menyuan, Xianmi, alt. 2800 m, on soil, 19 VIII 2004, W.Y. Zhuang & C.Y. Liu 5429, HMAS 97499.

Notes: The gross morphology of the fungus is similar to that described by Dennis (1978) and Häffner (1993). Ascospores seem slightly narrower than material from Europe.

Rhodoscypha ovilla Dissing & Sivertsen, Mycotaxon 16: 442, 1983.

Apothecia deeply cupulate with an small opening when young and becoming cupulate, tearing irregularly to open, with margin sometimes minutely dentate, sessile, 4-12 mm in diam., hymenium surface pink to orange-pink, receptacle surface downy, paler than hymenium; *hairs* arising from outer cells of the ectal excipulum, subcylindrical, straight or slightly undulate, hyaline, very thick- and smooth-walled, with a narrow lumen, up to 127 μm long and 20 μm wide, walls strongly refractive, neither dissolved in KOH aqueous solution and nor in Melzer's reagent, ca 6 μm thick; *ectal excipulum* of textura intricata, 80-150 μm thick, hyphae hyaline, thick-walled, walls 2-6(-9) μm thick; *medullary excipulum* of textura intricata, 100-800 μm thick, hyphae hyaline, 6-19 μm wide, walls somewhat refractive, 1-2 μm thick; *subhymenium* usually not clearly distinguishable from the medullary excipulum; *hymenium* 300-400 μm thick; *asci* operculate, 8-spored, subcylindrical above, with a narrow base, J- in Melzer's reagent, 18-22 μm wide; *ascospores* fusoid to broadly fusoid, hyaline, unicellular, biguttulate when young, with fine warts on surface, 31-39 $\times$ 10.7-14 μm , warts 0.2-0.6 μm in diam.; *paraphyses* subcylindrical with apex slightly enlarged, 5-8 μm wide above and 4-6 μm below.

Specimens examined: China. Qinghai, Datong, Dongxia, alt. 3000 m, on mossy soil, 17 VIII 2004, W.Y. Zhuang & C.Y. Liu 5384, 5397, HMAS 97500, 97501; Menyuan, Xianmi, alt. 2800 m, on mossy soil, 19 VIII 2004, W.Y. Zhuang & C.Y. Liu 5423, HMAS 97502; Qilian, Babaoxiang, alt. 2800 m, on mossy soil, 20 VIII 2004, W.Y. Zhuang & C.Y. Liu 5438, 5448, 5458, HMAS 97503, 97504, 97505.

Notes: The fungus is very characteristic by its pink apothecia, presence of interwoven hyphae on surface of the ectal excipulum, which are fairly thick-walled and hyaline, and the fusoid, finely marked ascospores. It was commonly found on the ground under conifer trees of different forests in Qinghai Province, which extends the distribution of the species from Europe, USA, and India (Dissing & Sivertsen, 1983) to northwestern China. Dissing & Sivertsen (1983) provided detailed description and illustrations of the fungus.

Harmaja (1977) and Dissing & Sievertsen (1983) had different opinions of hair morphology. Harmaja (1977) indicated the hairs as "the unusual thickness of sheath of the external hairs". Dissing & Sivertsen had a picture of hairs from a 2% KOH mount and stated that "hairs with thin inner wall and thick outer wall", which agrees to hairs shown in the Chinese material.

Harmaja (1977) described *Rhodoscypha ovilla* in detail, discussed its relationship to *Leucoscypha rhodoleuca* (Bres.) Svrček, and concluded that they are closely related but two different fungi. When morphology of the Chinese material of *R. ovilla* is compared with description and illustrations of *L. rhodoleuca* provided by Breitenbach & Kränzlin (1984), they are indeed similar to each other but with significantly distinct

hair morphology and ectal excipular structure. Apothecia of *L. rhodoleuca* are more or less semitranslucent compared with those of *R. ovilla*.

NAME CHANGE FOR A PREVIOUSLY DESCRIBED SPECIES

Spooneromyces daliensis (W.Y. Zhuang) W.Y. Zhuang, **comb. nov.**

≡ *Melastiza daliensis* W.Y. Zhuang, Fung. Divers. 18: 213, 2005.

Notes: As indicated in the original description, *Melastiza daliensis* is the most similar to *M. asperula* Spooner (Zhuang, 2005), a later synonym of *M. laeticolor* (P. Karst.) T. Schumach. which was proposed as the type species of a new genus *Spooneromyces* T. Schumach. & J. Moravec. A new species *S. helveticus* J. Breitenb. & F. Kränzlin with somewhat reticulate spore ornamentations was also included as one of the original species. Morphological features between *S. laeticolor* and taxa in the genus *Melastiza* are distinct. *Melastiza* and *Spooneromyces* are similar in the bright-colored apothecia, excipular structure, ornamented ascospores, and presence of hairs on receptacle surface. *Spooneromyces* differs in its stiff, somewhat pointed, multiseptate, and moderately thick-walled hairs instead of the short, obtuse, poorly developed ones in species of *Melastiza* (Schumacher & Moravec 1989; Hansen & Knudsen 2000). *M. daliensis* should be treated as a member of *Spooneromyces*.

Acknowledgements

The author would like to thank Prof. R. P. Korf for critical review of the manuscript and taxonomic insight, Prof. Z. L. Yang for serving as the pre-submission reviewer, Prof. D. H. Pfister and Dr. G. Wade of Harvard University for providing useful reprints, Mr. Y. Nong and Mr. C. Y. Liu for collecting jointly the specimens used in this work, Ms. X. Song for making the sections, Ms. J. Y. Xie for assistance with SEM study, and Mr. B. Liu for technical help. This project is supported by the National Natural Science Foundation of China (nos. 30230020, 30499340).

Literature cited

- Breitenbach J, Kränzlin F. 1984. Fungi of Switzerland. Volume 1. Ascomycetes [English translation]. Verlag Mykologia. Luzern.
- Cao JZ, Fan L, Liu B. 1990a. Notes on the genus *Gyromitra* from China. Acta Mycol. Sin. 9: 100-108. (in Chinese)
- Cao JZ, Fan L, Liu B. 1990b. Some new species and new records of the genus *Helvella* from China. II. Acta Mycol. Sin. 9: 184-190. (in Chinese)
- Dennis H. 1978. British Ascomycetes. J. Cramer. Vaduz.
- Dissing H, Sivertsen S. 1983. Operculate discomycetes from Rana (Norway) 5. *Rhodoscypha* gen. nov. and *Rhodotarzetta* gen. nov. Mycotaxon 16: 441-460.
- Häffner J. 1993. Die Gattung *Aleuria*. Rheinl.-Pfälz. Pilzjour. 3(1): 6-59.
- Harmaja H. 1977. *Leucoscypha ovilla* n. comb., a species new to Europe, found in northern Finland. Karstenia 17: 73-76.
- Hansen L, Knudsen H. 2000. Nordic Macromycetes. Vol. 1. Ascomycetes. Nordsvamp, Copenhagen.
- Mao XL. 1998. Economic Fungi of China. Science Press, Beijing. (in Chinese)
- Schumacher T. 1990. The genus *Scutellinia* (Pyronemataceae). Opera Bot. 101: 1-107.

- Schumacher T, Moravec J. 1989. *Spooneromyces*, a new genus to accommodate *Peziza laeticolor* and the new species *S. helveticus*. Nord. J. Bot. 9: 425-430.
- Zhang BC, Yu YN. 1990. Revision of Chinese species of *Geopora* (Pezizales). Acta Mycol. Sin. 11: 8-14. (in Chinese)
- Zhao ZY, Mao XL. 1986. Icones of Macrofungi from Xinjiang. Xinjiang Bayi Agricultural College, Urumqi. (in Chinese)
- Zhuang WY. 1998. Notes on discomycetes from Qinghai Province, China. Mycotaxon 66: 439-444.
- Zhuang WY. 2004. Preliminary survey of the *Helvellaceae* from Xinjiang, China. Mycotaxon 90: 35-42.
- Zhuang WY. 2005. Re-dispositions of specimens filed under *Lachnea* on deposit in HMAS. Fungal Diversity 18: 211-224.
- Zhuang WY, Wang Z. 1998. Discomycetes of tropical China. II. Collections from Yunnan. Mycotaxon 69: 339-358.

On three foliicolous *Helotiales* on *Dryas*

ANDRZEJ CHLEBICKI

chlebick@ib-pan.krakow.pl

Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46
PL-31-512 Kraków, Poland

MARKÉTA SUKOVÁ

marketa.sukova@nm.cz

Mycological Department, National Museum, Václavské nám. 68
CZ-115 79 Praha 1, Czech Republic

Abstract—Two species on *Dryas* spp. from Europe and Asia are described and illustrated. One of these is a new species, *Fuscolachnum hainesii* n. spec. and another is a new combination *Incrupulum uralense*.

Key words—fungi, discomycetes, *Incrupila*

Introduction

Microfungi on *Dryas octopetala* were recently thoroughly investigated (Chlebicki & Knudsen 2001, Chlebicki 2002, Chlebicki & Raitviir 2003, Chlebicki & Suková 2004). Eight taxa belonging to *Helotiales* were reported. One of the *Helotiales* published as *Fuscolachnum* sp. (Chlebicki 2002) is a new species in the genus *Fuscolachnum* J.H. Haines while another one, *Lachnum uralense* Chleb., should be transferred to the genus *Incrupulum* Baral. Recently Raitviir (2004) transferred *Lachnum crystallophorum* Nogrsek & Matzer to the genus *Incrupila* Raitv. Other species of *Helotiales* described on *Dryas* include: *Brunnipila dryadis* Nogrsek & Matzer (Nogrsek & Matzer 1991, Chlebicki 2002), *Crocicreas dryadis* (Nannf. ex L. Holm) S. E. Carp. var. *dryadis* [= *Grahamiella dryadis* (Nannf. ex L. Holm) Spooner], (L. Holm 1979, K. Holm & L. Holm 1984, Chlebicki 1995, 2002, Chlebicki & Suková 2004), *Crocicreas dryadis* var. *uniseptatum* Nogrsek & Matzer (Nogrsek & Matzer 1991, Chlebicki 1995, 2002, Chlebicki & Suková 2004), *Crocicreas variabile* Nogrsek & Matzer (Nogrsek & Matzer 1991, Chlebicki 2002, Chlebicki & Suková 2004), *Hymenoscyphus scutula* (Pers.) W. Phillips (Sprague 1955) and *Urceolella dryadicola* Raitv. (Chlebicki & Raitviir 2003, Chlebicki & Suková 2004, Raitviir 2004).

Material and Methods

Material was studied under a zoom stereo microscope Nikon SMZ 1500 and a light microscope (LM) Olympus BX-51 with an oil immersion lens, at magnification of

1000x. Slides in water were prepared for LM photographs of excipulum in longitudinal section. The amyloid reaction of the asco-apical apparatus was examined in Lugol's solution (IKI: 1% iodine, 3% KI in water), and Melzer's reagent (MLZ with 1% KOH pretreatment). Measurements refer to dead ascospores in water (*Fuscolachnum*) and living ascospores (*Incrucipulum*), other characters were measured in lactophenol. For SEM studies, dried apothecia were coated with gold, and photographed using scanning electron microscope PHILIPS and Fei Quanta 200. The material that was mentioned above is deposited in KRAM F and PRM. The Latin names of the orders and families follow Kirk *et al.* (2001) and Raitviir (2004).

Results

Fuscolachnum hainesii Chleb. & Suková *nov. sp.*, Helotiales, Lachnaceae

FIGS. 1, 2A

Diagnosis: Apothecia minuta, sessilia, cupuliformia, 300–320 μm diam. Pili fusci, cylindricei, 1–3-septati, tenuitunicati, 20.5–33 x 5.2–6.2 μm , sparse verrucis. Asci uncinati (30-) 33–37.5(–40) x 6–7.5(–8) μm , apicibus conicis, poro amyloideo. Sporae hyalinae, aseptatae, 9–10 x 1.5 μm . Paraphyses cylindricae 1.6–2 μm diam., apicibus obtusis, ascos nonsuperantibus. Excipulum externum textura angulari, cellulibus 5–7 x 3.5–6 μm magnis.

Hab. In foliis emortuis *Dryadis grandis*.

Holotype here designated: Russia, Chukotka Peninsula, eastern part of the Peninsula, valley of Nyrvakintveen River, near Ozernoye, Krest Bay, 28 July 1971, *leg.* Y.P. Kozhevnikov, Herb. LE.

Host: Leaves of *Dryas grandis*.

Etymology: The epithet *hainesii* refers to the mycologist John Haldor Haines from New York, who established the genus *Fuscolachnum*.

Description: Apothecia cup-shaped, sessile, 300–320 μm diam. Hairs brown, cylindrical, 1–3-septate, 20.5–33 x 5.2–6.2 μm , thin-walled, walls up to 0.5 μm thick, sparsely and coarsely granulate, warts slightly rounded at the top, lower warts mostly elongated. Asci clavate, arising from croziers, (30-)33–37.5(–40) x 6–7.5(–8) μm , with conical apices, apical pore blue in Lugol without KOH as well as blue in MLZ both without and with KOH pretreatment. Ascospores hyaline, with medium sized guttules (dead state), one-celled 9–10 x 1.5 μm . Paraphyses hyaline, filiform slightly enlarged below apex, straight, 1.6–2 μm diam., sometimes branched in lower part, with rounded apices, not exceeding asci. Ectal excipulum of textura angularis, cells 5–7 x 3.5–6 μm .

Comments: The sessile apothecia with fuscous, septate hairs covered by granules, and clavate ascospores are typical of *Fuscolachnum*. The granules of the new species are distinctly scattered in comparison with other species, e.g., *F. dumorum* (Roberge ex Desm.) J.H. Haines, *F. inopinatum* (Kirschst.) J.H. Haines, or *F. misellum* (Roberge ex Desm.) J.H. Haines. The hairs of *H. hainesii* more resemble those of *F. pteridis* (Alb. & Schwein.) J.H. Haines and its var. *tumidipila* J.H. Haines, but in *F. hainesii* the granules are even more scattered. Moreover, these 'granules' are not exuded by the hair cell but rather protrusions of the cell wall. For this reason we have some hesitation in placing

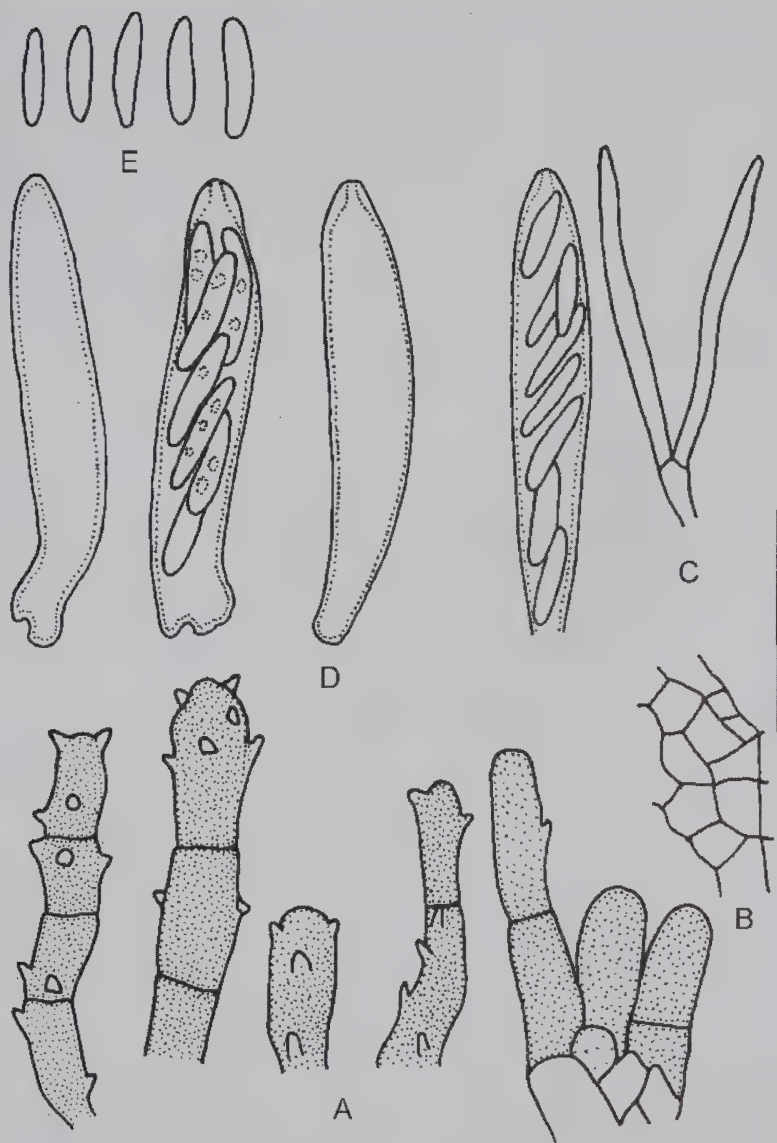
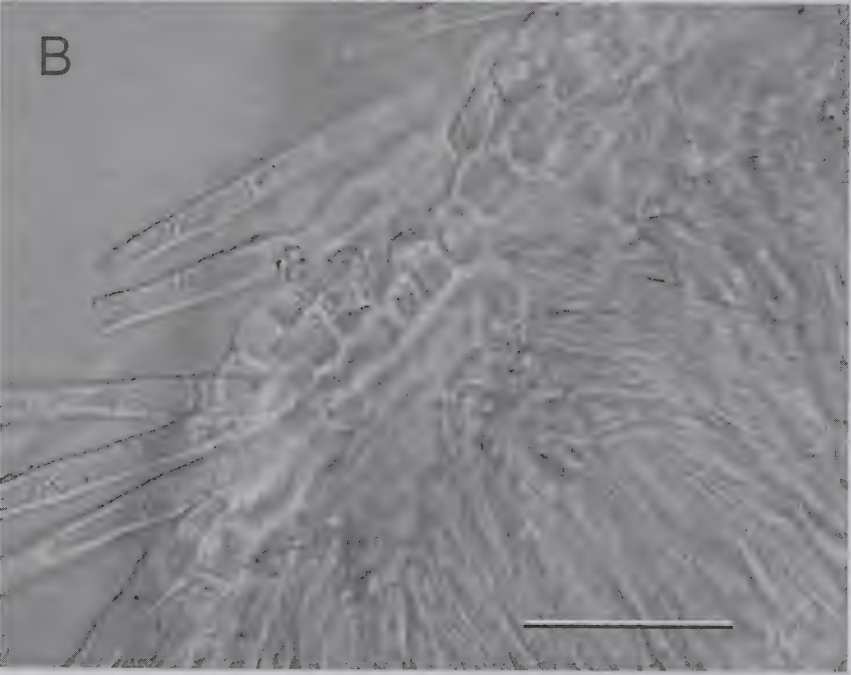
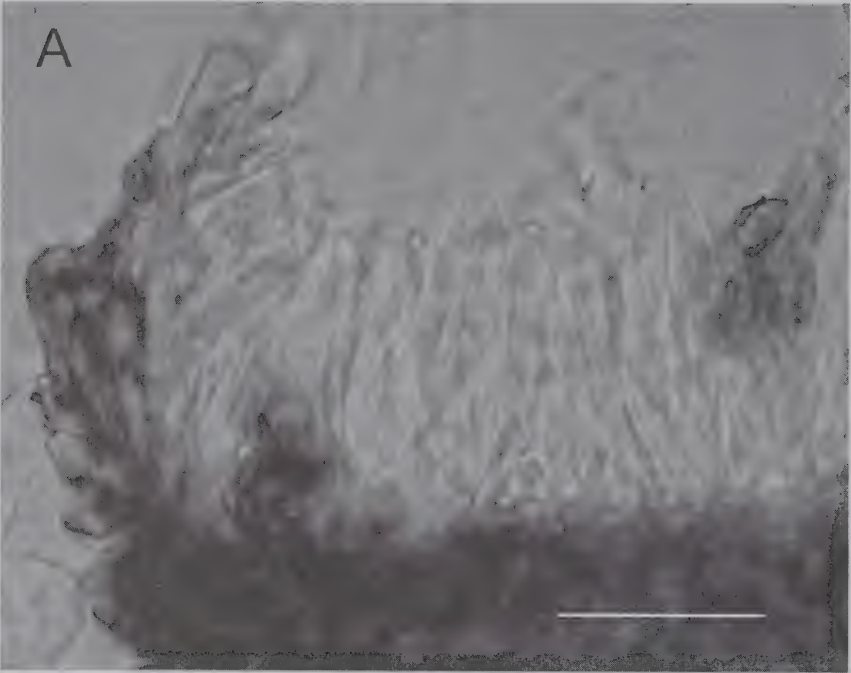


Fig. 1. *Fuscolachnum hainesii*: A - hairs with granules; B - part of excipulum (textura angularis); C - paraphyses, D - asci; E - ascospores (dead state). Scale bar = 20 μm

the new species in *Fuscolachnum*. At present only two species of *Fuscolachnum* are known from broadleaf plants: *F. misellum* and *F. dumorum* (Roberge ex Desm.) J.H.



Haines. But both these species possess hairs densely covered by granules and smaller ascospores. Paraphyses of *F. hainesii* are similar to these of *F. misellum*. Haines (1989) stated that the members of this genus are apparently host specific. We decided to describe this specimen as a new species in spite of very scanty material.

Incrucipulum uralense (Chleb.) Chleb. & Suková, **comb. nov.** *Helotiales*,
Lachnaceae (Figs. 3, 4A)

Basionym: *Lachnum uralense* Chleb., Monographiae Botanicae 90: 84, 2002.

Because at present the type material of *Lachnum uralense* contains only one apothecium and single slide, we decided to provide a more precise description.

Description: Apothecia subsessile, whitish to pale-yellow, 140-200 μm diameter, surface of ectal excipulum distinctly granulate, surface layer composed of thick-walled quadratic cells, hairs clavate, 3-6 septate, 90-130 x 5-7 μm , hair wall 1-2.2 μm thick, scabrous, each hair tipped by octahedral crystals, asci clavate, arising from simple septa, 50-52 x 7-8 μm , narrowed below to the basal septum, ascospores hyaline, narrowly ellipsoid-subfusoid, one-celled 12-15 x 3-4 μm , with 2-3(5) large oil drops, paraphyses linear sublanceolate, widest point near the apex, slightly longer than the asci, up to 60 μm long and 1-1.5 μm wide.

Comments: The genus *Incrucipulum* was introduced by Baral (in Baral & Krieglstainer 1985) for several species. We agree with Baral that *Incrucipulum* should be segregated from *Brunnipila*, *Capitotricha* and *Lachnum* on the basis of the excipular structure and character of the hairs. In longitudinal section the excipulum contains characteristic thick-walled quadratic cells in the surface layer. The hairs of *Incrucipulum* are warty, moderately thick-walled to thick-walled, tipped by apical crystals. Hair wall thickness of *I. uralense* is similar to that in *I. virmbergense* (Matheis) Baral (Tab. 1).

Also ultrastructural studies of the morphology of the hair wall and ascus apical apparatus provide good support to identify the genera *Lachnum* s. str., *Brunnipila*, *Capitotricha* and *Incrucipulum* (Leenurm et al. 2000).

Hairs of *Lachnum uralense* are tipped by octahedral crystals. Similar crystals were observed also in *Incrucipulum ciliare* (Schr.: Fr.) Baral (Fig. 4B). As the type of *L. uralense* contains only one apothecium and the character of the hairs is almost the same as in *I. ciliare*, we are sure that *L. uralense* belongs to the genus *Incrucipulum* (despite not studying the apothecium in longitudinal section). The excipulum of *I. ciliare* in longitudinal section contains the characteristic surface layer of thick-walled quadratic cells (Fig. 2B). Similar thick-walled quadratic cells covered by granules we observed in *L. uralense* in surface view.

Specimens examined: RUSSIA: Polar Ural Mts., patches of mountain tundra near unnamed pass, 510 m elev., 12 km S of Polyarnyj Ural railway station, on lower side of leaves of *Dryas octopetala*, 25 July 1995, coll.: A. Chlebicki (Holotype: KRAM F 43247).

Fig. 2. A - section of margin of apothecium of *Fuscolachnum hainesii*, LE. Scale bar 20 μm ; B - Excipulum of *Incrucipulum ciliare* (Schr.: Fr.) Baral in longitudinal section, PRM 900015. Scale bar 30 μm

Comparative material of non-dryadicolous species of *Incrucipulum* studied:

Incrucipulum ciliare, Austria, Styria, Leibnitzer Feld, ca. 6.5 km NNE of Leibnitz, "Haslacher Auen", 280 m elev., 46° 50' N, 15° 33' E, on leaves of *Quercus robur*, 10 September 2002, coll.: M. Suková, PRM 900015.



Fig. 3. *Incrucipulum uralense*: A – hair, B – extal excipulum, textura angularis, C – asci, D – paraphyses, E – ascospores, scale bar = 20 μ m

Fig. 4. A – *Incrucipulum uralense* – SEM photographs of apical crystals of hairs; B – *Incrucipulum ciliare* (Schröd.: Fr.) Baral – SEM photograph of apical crystals of hairs, PRM 900015

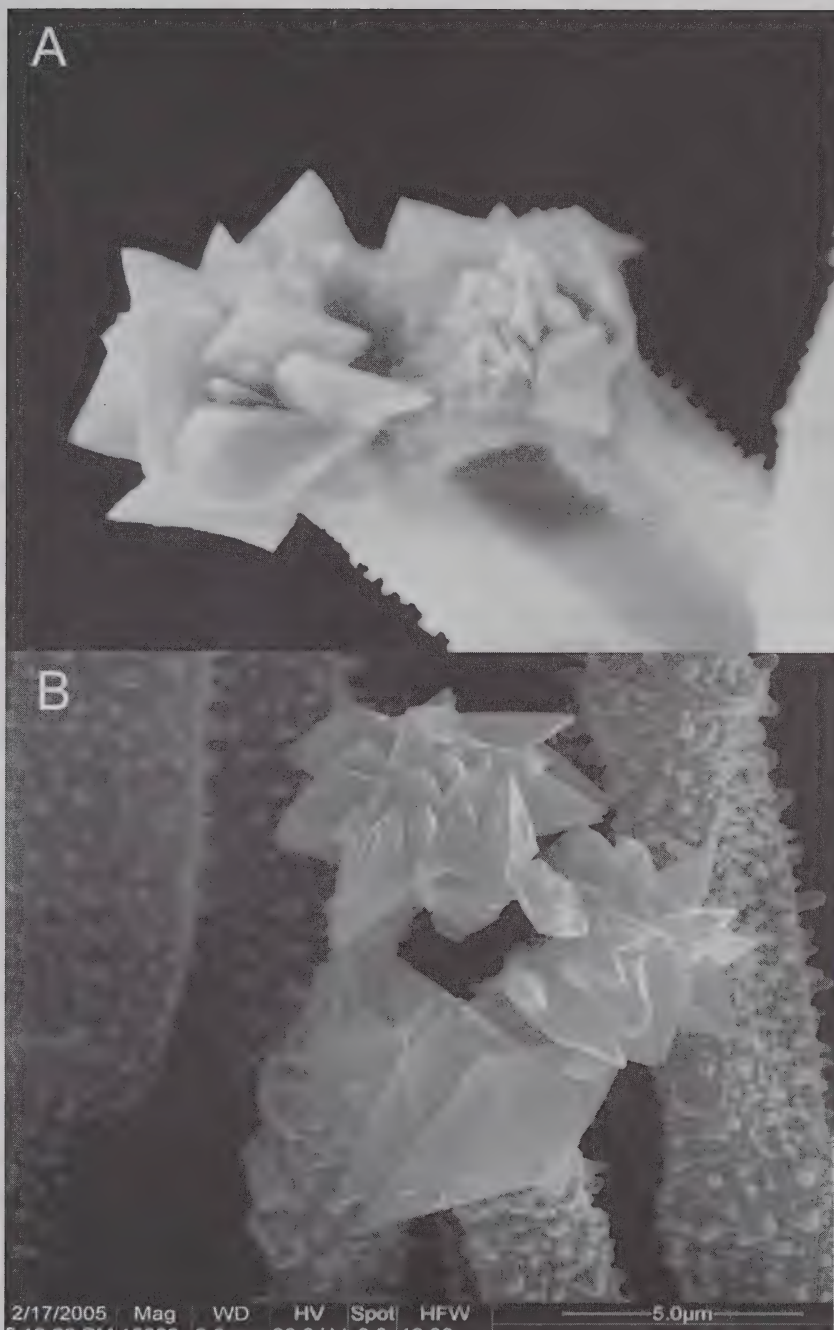


Table 1. Hair wall thickness of some species of the genus *Incrucipulum*

Fungus	Wall thickness [μm]	Source
<i>Incrucipulum capitatum</i>	0.6-2.3	PRM 900745 – herb. material in KOH
<i>Incrucipulum ciliare</i>	0.5-1.2(1.4)	PRM 900015 – herb. material in KOH
<i>Incrucipulum ciliare</i>	0.5-1	Baral (2003) – living material
<i>Incrucipulum virmbergense</i>	(1-)1.5-2.5(-3)	Baral (2003) – living material
<i>Incrucipulum virmbergense</i>	2-2.5	Matheis (1977)
<i>Lachnum uralense</i>	1.5-2.5	KRAM F 43247 – herb. material in lactophenol

Incrupila crystallophora (Nogrsek & Matzer) Raitv., Scripta mycologica 20: 77, 2004. *Helotiales, Hyaloscyphaceae*

Basionym: *Lachnum crystallophorum* Nogrsek & Matzer, Nova Hedwigia 53: 455, 1991.

Comments: This interesting species was reported from the Eastern Carpathians in our previous article (Chlebicki & Sukova 2004). Raitviir (2004) transferred *Lachnum crystallophorum* to the genus *Incrupila* Raitv. We agree with the taxonomic decision of Raitviir.

Acknowledgements

Hans Otto Baral carefully read the manuscript, suggested many improvements. We thank Richard Paul Korf for valuable comments on our manuscript and Dr. Mirko Svřek for correcting Latin. This work was supported by a grant of the Ministry of Culture of the Czech Republic (Projects No. RK04P03OMG010 and MK00002327201) and by the Ministry of Science and Information Society Technologies, Poland (Project No. 2 P04F 066 28). Dr. Amy Rossman gave assistance with English.

Literature cited

- Baral HO & Krieglsteiner GJ. 1985. Bausteine zu einer Ascomyceten-Flora der BR Deutschland: In Süddeutschland gefundene Inoperculate Discomyzeten mit taxonomischen, ökologischen und chorologischen Hinweisen. Beih. Zeitschr. Mykol. 6: 1-160.
- Chlebicki A. 1995. Microfungi on *Dryas* extracted from Polish phanerogam herbaria. Acta Soc. Bot. Pol. 64, 4: 393-407.
- Chlebicki A. 2002. Biogeographic relationships between fungi and selected glacial relict plants. The use of host-fungus data as an aid to plant geography on the basis of material from Europe, Greenland and northern Asia. Monogr. Bot. 90: 1-230.

- Chlebicki A & Knudsen H. 2001. Dryadicolous microfungi from Greenland. 1. List of species. Acta Soc. Bot. Pol. 69, 4: 291-301.
- Chlebicki A & Raitviir A. 2003. Some new records and species of dryadicolous fungi from Greenland and northern Asia. Mycotaxon 86: 215-226.
- Chlebicki A & Suková M. 2004. Fungi of alpine islands of *Dryas octopetala* in the Carpathians. Mycotaxon 90(1): 153-176.
- Haines JH. 1989. Studies in the *Hyaloscyphaceae*. IV: *Fuscolachnum*, a new genus for *Dasyscyphus pteridis*. Mem. New York Bot. Gard. 49: 315-325.
- Hayes AJ & Rheinberg P. 1975. Microfungal populations of the Abisko area, Northern Sweden. In: F.E. Wielgolaski (ed.), Fennoscandian Tundra Ecosystems, pp. 244-250. Springer-Verlag, Berlin-Heidelberg-New York.
- Holm K & Holm L. 1984. A contribution to the mycoflora of Iceland. Acta Bot. Islandica 7: 3-11.
- Holm L. 1979. Microfungi on *Dryas*. Bot. Not. 132: 77-92.
- Kirk PM, Cannon PF, David JC & Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the fungi. Ed. 9. CAB International, Surrey UK.
- Leenurm K, Raitviir A & Raid R. 2000. Studies on the ultrastructure of *Lachnum* and related genera (*Hyaloscyphaceae*, *Helotiales*, Ascomycetes). Sydowia 52(1): 30-45.
- Matheis W. 1977. Über einige *Dasyscyphus*-Arten auf Blättern von *Vaccinium*. Sydowia 29: 237-244.
- Nogrask A & Matzer M. 1991. Nicht-pyrenokarpe Ascomyceten auf Gefäßpflanzen der Polsterseggenrasen. I. Arten auf *Dryas octopetala*. Nowa Hedwigia 53, 3-4: 445-475.
- Raitviir A. 2004. Revised Synopsis of the *Hyaloscyphaceae*. Scripta Mycologica (Tartu) 20: 1-133.
- Sprague R. 1955. A check list of fungi of glacier bay, Alaska. Res. Stud. State Coll. Wash. 23: 202-224.

***Cercospora agavicola* – a new foliar pathogen of *Agave tequilana* var. *azul* from Mexico**

VICTORIA AYALA-ESCOBAR & MARÍA DE JESÚS YAÑEZ-MORALES

ayalav@colpos.mx

Instituto de Fitosanidad, Colegio de Postgraduados,

Km 36.5-Carr. México-Texcoco, Montecillo, C.P. 56230, Edo de México, Mexico

UWE BRAUN

uwe.braun@botanik.uni-halle.de

*Martin-Luther-University, Institute of Geobotany and Botanical Garden, Herbarium,
Neuwerk 21, D-06099 Halle (Saale), Germany*

JOHANNES Z. GROENEWALD & PEDRO W. CROUS

e.groenewald@cbs.knaw.nl & crous@cbs.knaw.nl

*Centraalbureau voor Schimmelcultures, Fungal Biodiversity Centre
Uppsalalaan 8, NL-3584 CT Utrecht, The Netherlands*

Abstract — *Cercospora agavicola* is newly described and illustrated on *Agave tequilana* var. *azul* from Mexico. Koch's postulates were successfully completed, confirming *C. agavicola* as the causal organism of *Agave* leaf spot and necrosis. *C. agavicola* is compared to cercosporoid species based on sequence data derived from the ITS nrDNA region, and part of the elongation factor 1- α , actin, calmodulin and histone H3 genes. Its taxonomic position, generic affinity and relatedness to allied species are discussed on the basis of morphological and molecular data.

Key words — mitosporic fungi, *Mycosphaerella* anamorphs, North America

Introduction

Agave cantula Roxb., *A. cupreata* Trel. & A. Berger, *A. longisepala* Tod., *A. palmaris* Trel., *A. pesmulae* Trel., *A. pseudotequilana* Trel., *A. subtilis* Trel. and *A. tequilana* F.A.C. Weber var. *azul* are cultivated in Mexico in the states of Guanajuato, Jalisco, Michoacán, Nayarit and Tamaulipas (Anonymous 2002). The latter species is the most economically significant cultivated agave because of its importance for 'tequila' extraction (Villalvazo 1986, Granados 1993). Penjamo in the state of Guanajuato is one of the regions in which agave was initially planted as crop. In January 2003, collaborators from the Agricultural Department of the State of Guanajuato observed a new disease on *Agave tequilana*. A fungus associated with symptomatic tissue was identified at the Instituto de Fitosanidad, Colegio de Postgraduados (CP) as an undescribed member

of the genus *Cercospora* Fresen. Material was sent to U. Braun in Germany for confirmation of the identification. Additionally, molecular analyses of the ITS nrDNA region, and part of the elongation factor 1- α , actin gene, calmodulin and histone H3 genes were carried out at CP and at the Centraalbureau voor Schimmelcultures in Utrecht, the Netherlands.

Materials and methods

Isolates

Isolates were obtained from symptomatic leaf pieces by placing disinfested necrotic tissue fragments in moisture chambers to enhance sporulation. Monoconidial cultures were subsequently established on water-agar (WA) (20 g agar / 1 L distilled water). Colonies were induced to sporulate on four different media: WA, agave-agar (AA) (40 g of agave leaf fragments boiled for 10 min and then blended with 20 g agar / 1 L distilled water), oatmeal-agar (OA) (15 g of oatmeal, 20 g agar / 1 L distilled water), and potato-dextrose agar (PDA) (200 g potatoes, 20 g dextrose, 20 g agar / 1 L distilled water). Dishes of all media were point inoculated and incubated for 3 wk at $\pm 24^{\circ}\text{C}$ under continuous near-ultraviolet light, and inspected for sporulation at 3 d intervals. Morphological observations *in vitro* were based on sporulating cultures on AA. Thirty observations were made of each structure, with extremes given in parentheses.

DNA isolation, amplification and phylogenetic analysis

The protocol of Lee & Taylor (1990) was used to isolate genomic DNA from fungal mycelium of a monoconidial culture grown on MEA in Petri dishes. The primers ITS1 and ITS4 (White et al. 1990) were used to amplify part (ITS) of the nuclear rRNA operon spanning the 3' end of the 18S rRNA gene, the first internal transcribed spacer (ITS1), the 5.8S rRNA gene, the second ITS region and the 5' end of the 28S rRNA gene. To obtain additional sequence information, four other loci were sequenced. Part of the elongation factor 1- α gene (EF) was amplified with primers EF1-728F and EF1-986R, part of the actin gene (ACT) with primers ACT-512F and ACT-783R and part of the calmodulin gene (CAL) with primers CAL-228F and CAL-737R (Carbone & Kohn 1999). Part of the histone H3 gene (HIS) was amplified with primers H3-1a and H3-1b (Glass & Donaldson 1995). The PCR conditions, sequence alignment and subsequent phylogenetic analysis followed the methods of Crous et al. (2004a). To determine the taxonomic position of the fungus, the sequences were added to a subset of the alignment (TreeBASE matrix M2038) of Crous et al. (2004b). Sequence data were deposited in GenBank.

Koch's postulates

Pathogenicity tests were conducted on six-month-old healthy seedlings of *A. tequilana* var. *azul* that were produced in the region of Tequila, Jalisco. The experiment consisted of six plants, of which 10 leaves per plant were inoculated (five wounded via a sterile toothpick, five unwounded). Agar disks (0.5 cm diam) colonized by the fungus were placed at the base of each leaf. All plants were incubated in a moist chamber ($\pm 90\%$ relative humidity) for 24 h, and subsequently transferred to a glasshouse ($\pm 28^{\circ}\text{C}$,

normal daylight) until symptoms appeared. Controls consisted of two plants that were inoculated in a similar fashion with uncolonized agar plugs. Reisolations were made onto PDA to confirm Koch's postulates.

Results

DNA Phylogeny

Approximately 500, 315, 230, 320 and 410 bases were determined for ITS, EF, ACT, CAL, and HIS, respectively (GenBank accession numbers AY647237, AY966897, AY966898, AY966899, AY966900, respectively). A partition homogeneity test using the sequence data showed that all loci could be combined ($p = 0.073$) into a single analysis.

The data matrix contained 17 taxa (including the two outgroups) and 1702 characters including alignment gaps. Of these characters, 603 were parsimony-informative, 124 were variable and parsimony-uninformative, and 975 were constant. Neighbor-joining analysis using the three substitution models on the sequence data yielded trees with similar topology and bootstrap values. Parsimony analysis of the alignment yielded three most parsimonious trees (TL = 1230 steps; CI = 0.921; RI = 0.960; RC = 0.885), one of which is shown in Fig. 1. The neighbor-joining (using the uncorrected p, Kimura 2-parameter and F84 substitution models) and parsimony analyses provided trees with the same topology (data not shown). All of the *Cercospora* isolates formed a well-supported group (100 % bootstrap support) with the sequences of *Cercospora apii* and *C. beticola* clustering together with a bootstrap support value of 100 %. The isolate from *Agave tequilana* var. *azul* formed a distinct branch in the *Cercospora* clade, separate from the other *Cercospora* species in the tree.

Taxonomy

Cercospora agavicola Ayala-Escobar, **sp. nov.** MB500188

Figs 2–14

Differt a C. fourcroyae conidiophoris 20–100 µm longis, conidiis cylindraceis, ad apicem interdum distincte inflatis.

Holotype here designated: on *Agave tequilana* var. *azul* (Agavaceae), Mexico, State of Guanajuato, Penjamo, Jan. 2003, V. Ayala-Escobar and Ma. de Jesús Yáñez-Morales (CHAPA # 166), culture ex-type CBS 117292, CPC 11774.

Isotype: HAL 1839 F.

In vivo: Forming irregular necroses of variable size on leaves, dingy gray. Colonies punctiform to pustulate, scattered to dense, dark to blackish brown, later gray-brown to grayish white by abundant conidial formation, scattered to confluent, dense. Mycelium internal. Hyphae sparingly branched, 1.5–5 µm wide, septate, subhyaline to brownish, smooth, hyphae solitary or forming lax to dense ropes or planate aggregations of swollen cells up to 15 µm diam. Stromata well-developed, immersed, often somewhat erumpent, 20–150 µm diam or confluent and larger, composed of swollen hyphal cells,

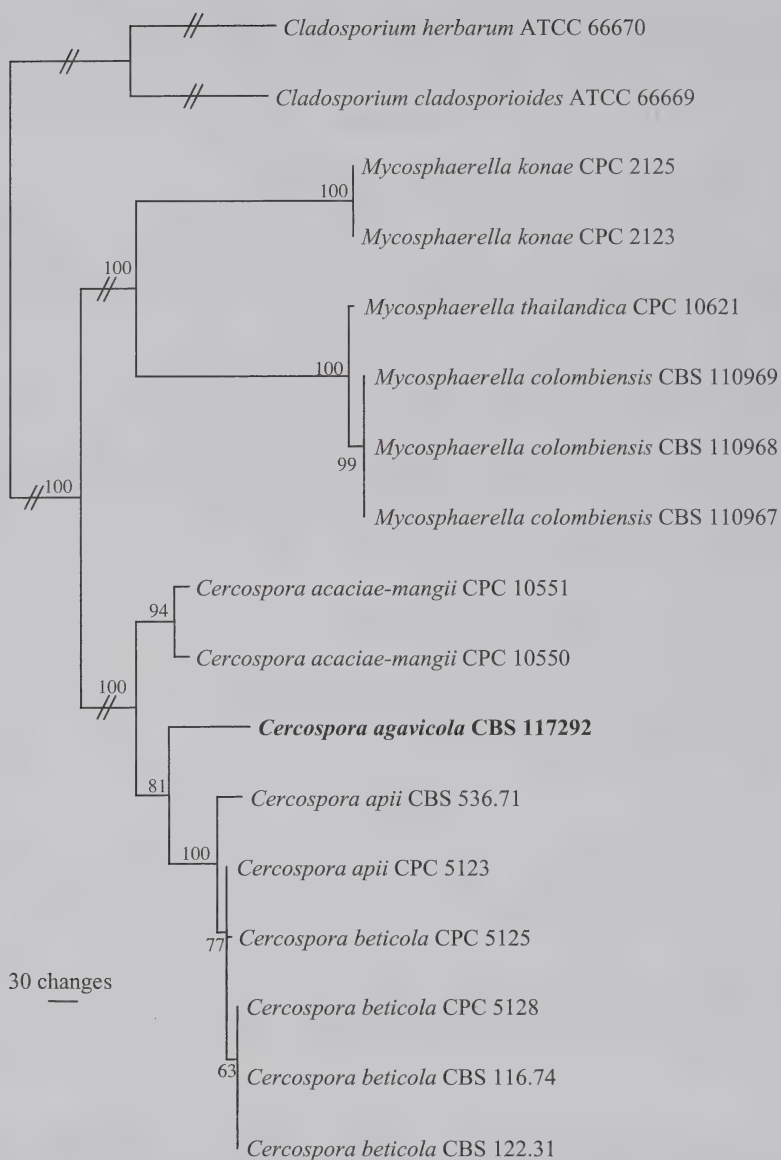
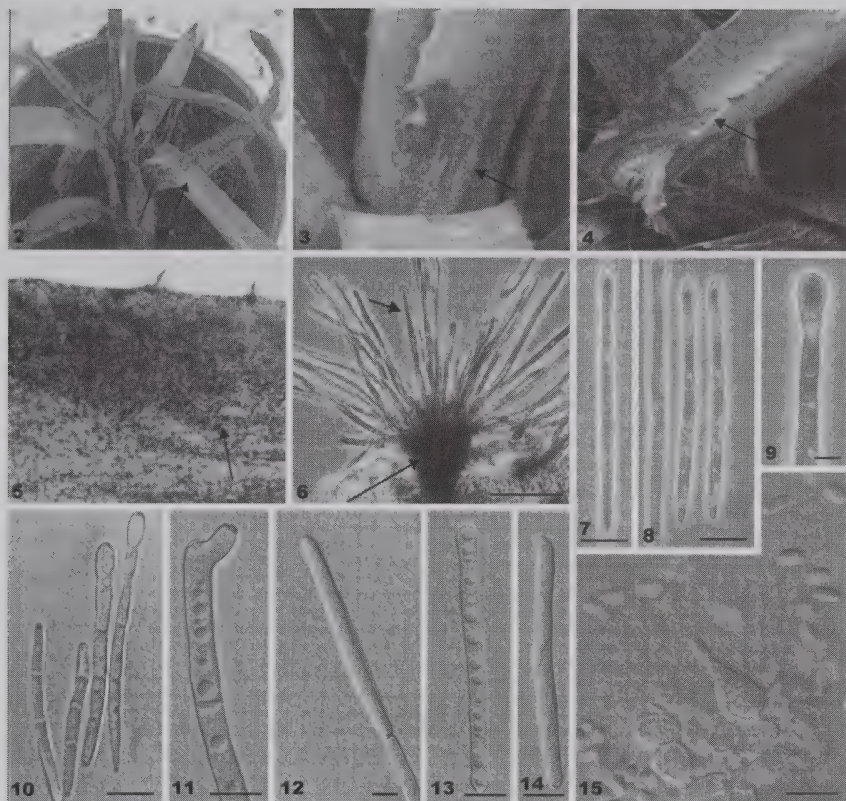


Fig. 1. One of three most parsimonious trees obtained from a heuristic search with 100 random taxon additions of the combined sequence alignment. The scale bar shows 30 changes and bootstrap replicate values from 1000 replicates are shown at the nodes. Strict consensus branches are thickened. The tree was rooted to two *Cladosporium* species. GenBank accession numbers of the sequences from TreeBASE matrix M2038 can be found in Crous et al. (2004b).



Figs 2–14. Disease symptoms and morphological structures of *Cercospora agavicola* on *Agave tequilana* var. *azul*. **2.** Leaf and stem necrosis. **3.** Basal necrosis of a leaf, 3 wk after inoculation. **4.** Basal leaf necrosis 3 mo after inoculation. **5.** Multiple dark stromata covering the basal leaf area. **6.** Fasciculate conidiophores arising from a basal stroma. **7–10.** Hyaline conidia with swollen apical cells *in vivo*. **11.** Brown conidiogenous cells with loci. **12.** Conidiogenous cell giving rise to a conidium. **13–14.** Conidia *in vitro*. **15.** Spermatogenous cells with spermatia *in vitro*. Scale bars: 5 = 100 μm , 6–7, 9 = 15 μm , 10–14 = 10 μm , 8 = 5 μm .

3–8 μm wide, brown. Conidiophores in small to moderately large, lax fascicles, erect, divergent, subcylindrical-filiform to flexuous-sinuuous, barely geniculate, unbranched, occasionally with constrictions and swellings, 20–100 $\times$ 3–6(–7) μm (up to 200 μm in length and strongly branched under high humidity in moisture chambers), pluriseptate, at first subhyaline, later pale olivaceous, olivaceous-brown or pale brown, often paler towards the apex, thin-walled, smooth; conidiogenous cells integrated, terminal, 10–40 μm long; with a single or up to three conidiogenous loci, terminal and lateral, 2–3 μm diam, thickened and darkened. Conidia solitary, subcylindrical, (35–)40–100(–120) $\times$ 3–5.5 μm , (0–)3–8-septate, hyaline, thin-walled, smooth, apex obtuse, sometimes with distinctly swollen tips, base truncate to slightly obconically truncate, 1.5–2.5 μm wide, hila somewhat thickened and darkened.

In vitro: Colonies on all culture media green to grayish, reaching 2 cm diam within 3 wk. Sporulation only observed on AA medium after 21 d. Conidiophores dense, 231–960 μm long, pluriseptate, with a single terminal conidiogenous locus or up to five slightly protruding lateral loci. Conidia straight, cylindrical, 25–120 μm long, 2–8-septate, hyaline, apical cells often swollen, subglobose to clavate. Spermatogonia formed on OA, exuding masses of hyaline, rod-shaped spermatia, $3\text{--}6 \times 1\text{--}2 \mu\text{m}$.

Koch's postulates

Disease symptoms were observed after 10 d, and consisted of pale to dark brown spots. Lesions were 3–4 cm long and 2 cm wide after 21 d, while the whole leaf (15 cm long) turned necrotic after 3 mo, also extending to the stem (Figs 2–4). *C. agavicola* was successfully re-isolated from the margins of symptomatic leaves within 2–3 wk after inoculation. No disease developed on unwounded leaves. Control plants remained healthy. Inoculated, wounded leaves developed stromata (Fig. 5), which, when placed in moist chambers, produced conidiophores within 5 d and conidia after 8 d.

Discussion

Cercospora leaf spot and necrosis is a new disease of *Agave* in Mexico and, as such, it is not known if this fungus also occurs in other states where the crop is grown. The common occurrence of spermatogonia on host material, as well as *in vitro* on agar media, suggests that it is very likely that this pathogen also has a *Mycosphaerella* teleomorph.

The generic affinity of this fungus to *Cercospora* was confirmed by BLASTn results obtained with the sequence data. The ITS sequence was highly similar to sequences of '*Cercospora sorghi* var. *maydis* Ellis & Everh.' (AF 297229, Goodwin et al. 2001; 99.8 % similarity), *C. nicotianae* Ellis & Everh. (AF 297230, Goodwin et al. 2001; with the same similarity as previous taxon) and *C. asparagi* Sacc. (AF 297229, Goodwin et al. 2001; 2 bp different). '*Cercospora sorghi* var. *maydis*' is quite distinct from and not conspecific with *C. sorghi* s. str. (Chupp 1953, Goodwin et al. 2001) and, together with *C. nicotianae* and *C. asparagi*, belongs to the *C. apii* complex (Crous & Braun 2003). *C. agavicola* is genetically close to *C. apii* s. lat. based on ITS sequence data, but morphologically quite distinct by having very large stromata and consistently cylindrical conidia, often with swollen tips. From the phylogenetic tree obtained using the combined sequence data of five genomic loci, it is clear that *C. agavicola* is also genetically distinct from *C. apii* s. lat. *C. floricola* Heald & F.A. Wolf on *Yucca* spp. and *C. fourcroyae* Obreg.-Bot. on *Alstroemeria* sp. (*Alstroemeriaceae*) and *Fucrea* (*Fourcroya*) *gigantea* are two *Cercospora* species on hosts belonging to the *Agavaceae*. The latter species is morphologically close to *C. agavicola*, but differs in having very long conidiophores (up to 350 μm *in vivo*) and cylindrical-obclavate conidia without any apical swellings (Chupp 1953). *C. floricola* is characterized by its uniformly short conidiophores, 10–35 μm long, and cylindrical-obclavate conidia, 15–60(–70) $\times$ 3–6 μm , with 1–3(–5) septa, and non-swollen tips (type material of *C. floricola* examined: BPI 436450). *C. haemanthi* Kalchb. on *Haemanthus* and *Scadoxus* species of the allied family *Amaryllidaceae* is morphologically also close to the new species, but

distinguished by having larger conidiogenous loci, 3–4 μm diam, obclavate-cylindrical to subacicular wider conidia, (20–)40–120(–220) $\times$ 4–8 μm , without any swollen tips (type material of *C. haemanthi* examined: B).

Acknowledgements

Sincere thanks are due to CONACYT (from Mexico) project 38409-V (Fungal Biodiversity) for funding, and to Dr. Héctor González Hernández from CP for providing the healthy *Agave* seedlings used in inoculation studies. Furthermore, we are much obliged to Dr. Gerardo S. Leyva Mir from the Autonomous University of Chapingo in México for his valuable scientific comments. Drs Vyrna Beilharz and Mary Palm-Hernandez are also thanked for reviewing the script.

Literature cited

- Anonymous 2002. Antecedentes y objetivos del Consejo regulador del tequila. Guadalajara, Jalisco: México. <<http://www.crt.org.mx>>.
- Carbone I, Kohn LM. 1999. A method for designing primer sets for speciation studies in filamentous ascomycetes. *Mycologia* 91: 553–556.
- Chupp C. 1953. A monograph of the fungus genus *Cercospora*. Ithaca, New York, USA.
- Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Series 1: 1–569.
- Crous PW, Groenewald JZ, Mansilla JP, Hunter GC, Wingfield MJ. 2004a. Phylogenetic reassessment of *Mycosphaerella* spp. and their anamorphs occurring on *Eucalyptus*. *Stud. Mycol.* 50: 195–214.
- Crous PW, Groenewald JZ, Pongpanich K, Himaman W, Arzanlou M and Wingfield MJ. 2004b. Cryptic speciation and host specificity among *Mycosphaerella* spp. occurring on Australian *Acacia* species grown as exotics in the tropics. *Stud. Mycol.* 50: 457–469.
- Glass NL, Donaldson G. 1995. Development of primer sets designed for use with PCR to amplify conserved genes from filamentous ascomycetes. *Appl. Environ. Microb.* 61: 1323–1330.
- Goodwin SB, Dunkle LD, Zismann VL. 2001. Phylogenetic analysis of *Cercospora* and *Mycosphaerella* based on the Internal Transcribed Spacer Region of ribosomal DNA. *Phytopathology* 91: 648–658.
- Granados SD. 1993. Los Agaves de México. Universidad Autónoma Chapingo. México.
- Lee SB, Taylor JW. 1990. Isolation of DNA from fungal mycelia and single spores. In: Innis MA et al. (eds.) *PCR Protocols: a guide to methods and applications*, pp. 282–287. San Diego: Academic Press.
- Villavazo RAS. 1986. El cultivo del mezcal (*Agave tequilana* Weber) en la región de Tequila, Jalisco. Tesis Profesional. Universidad Autónoma Chapingo. México.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA et al. (eds) *PCR Protocols: a guide to methods and applications*, pp. 315–322. San Diego: Academic Press.

***Albatrellus ginnsii* sp. nov.**

A.B. DE

Department of Botany, Burdwan Raj College
Burdwan-713104, West Bengal, India

Abstract — A new species of *Albatrellus*, *A. ginnsii*, is described and illustrated. The new species was found growing in soil under a *Ficus benghalensis* tree in Calcutta, West Bengal, India.

Key words — Basidiomycetes, *Polyporaceae*, taxonomy

Introduction

During a mycological excursion at Calcutta, West Bengal, India, the author collected some fresh poroid basidiocarps found growing in soil near a *Ficus benghalensis* L. tree. A microscopical examination showed it to be an *Albatrellus* species. A search of the available literature (Domanski et al. 1973, Gilbertson & Ryvarden 1986, Ginns 1994, 1997, Pouzar 1972, Roy & De 1996, Ryvarden 1976, Ryvarden & Johansen 1980, Smith & Smith 1973) gave no clue to its identity, and it was concluded that it represented an undescribed species.

Albatrellus ginnsii* A.B. De, sp. nov.*FIGURES 1-11**

Fructificatio stipitata; pileus albus, laeves, 0.6-1.4 cm in diametro, 1-2 mm crassa; contextus albus; pori facies albus, pori 2-3 per mm; systema hypharum monomiticum, hyphae generativae hyalinae, non fibulatae vel fibulatae; basidia hyalina, 25-37 × 8 µm; basidiosporae subglobosae vel ellipsoideae, 6-7 (-9) × 4.5-5.0 (-5.5) µm, levis, hyalinae, tenuitunicatae, amyloideae, apiculo prominenti, noncyanophiles.

Etymologia: Secundum nomen Dr. J.H.Ginns.

Holotypus hic designatus: Lectus ad locum Calcutta, West Bengal, India, die 16 Octobri, 1998 et positus in herbario fungorum in sectio Botanicae, Burdwan Raj College, Burdwan, West Bengal, India (sub numero BRCMH A981); isotypus in herb. DAOM (Canada) conservatus (DAOM 227124).

Basidiocarp annual, terrestrial, centrally stipitate, white, soft and succulent when fresh, drying soft and brittle, caespitose, number of basidiocarps in a bunch was found to be up to six; pileus circular with an acute umbo, 0.6-1.4 cm in diameter, 1-2 mm thick; upper surface (Fig. 1) of pileus white, glabrous, azonate, margin rounded, concolourous, entire, inturned on drying, sterile; pore surface (Figs. 1 & 2) white, no colour change when touched or scraped or only slightly discoloured, not shining, pores circular to

angular, 2-3 per mm, pore tubes not stratose, concolourous with pore surface, up to 1 mm deep; context white, less than 1 mm thick, homogeneous; subhymenium 20 μm thick; stipe central, white, up to 2 cm long and 2-3 mm thick, solid, glabrous, unbranched, somewhat flattened with median longitudinal furrow, base of stipe slightly expanded and bulbous, up to 4 mm in diameter, fused with stipes from other fruitbodies at the bulbous basal part.

Hyphal system monomitic, generative hyphae (Fig. 7) hyaline, thin-walled to very slightly thick-walled, variously inflated, in extreme cases up to 35 μm in diameter in inflated parts, branched, simple septate with rare clamp connections, in context (Fig. 4) and stipe generative hyphae are mostly unbranched, running parallel in a dense structure, hyphae in the subhymenium 2.5-3.0 μm in diameter, with clamp connections, tramal hyphae 3-12 μm in diameter, with clamp connections and simple septa, the walls hyaline, thin, with rosy oily inclusions. Gloeoplerous hyphae (Figs. 3&8) 3.5-7.0 μm in diameter. Basidia (Figs. 5&9) clavate, $25-37 \times 8 \mu\text{m}$, hyaline, thin-walled with a basal clamp connection ($n = 8$), tetrasterigmate, very rarely bisterigmate, each sterigma 5 μm long when mature, contents typically with oily inclusions. Basidiospores (Figs. 6 & 10) subglobose to broadly ellipsoid to ellipsoid, $6-7 (-9) \times 4.5-5.0 (-5.5) \mu\text{m}$ ($n=20$), $l/w = 1.2-1.5$, the walls thin, hyaline, smooth, apiculate, weakly amyloid, acyanophilous, often with oily inclusions. Cystidioles (Fig. 11) hyaline, thin-walled, smooth, $15-20 \times 3.5-5.0 \mu\text{m}$.

Habitat: On soil adjacent to a *Ficus benghalensis* L. tree.

Type Locality: Calcutta, West Bengal, India.

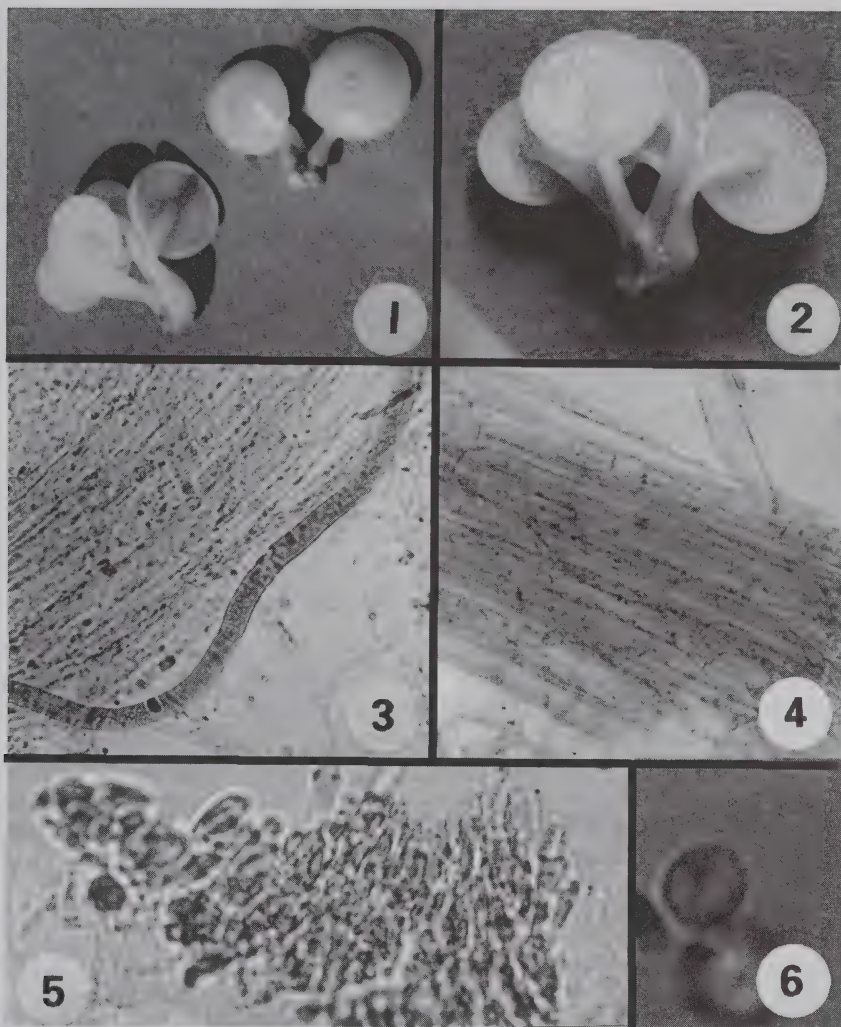
Etymology: The species name has been coined after the celebrated Canadian mycologist, Dr. J. H. Ginns.

Discussion

Albatrellus Gray is a genus of the family *Polyporaceae* sensu lato that is characterised by stipitate, fleshy basidiomes with a poroid hymenophore, monomitic hyphal system with inflated generative hyphae (with or without clamp connections), frequent gloeoplerous hyphae, and basidiospores that are hyaline, thin-walled, and ellipsoid to globose (Domanski et al. 1973; Ginns 1994, 1997; Pouzar 1972; Roy & De 1996; Ryvarden 1976; Ryvarden & Johansen 1980; Smith & Smith 1973). As the fungus described above possesses almost all of these characters, it is described in the genus *Albatrellus*.

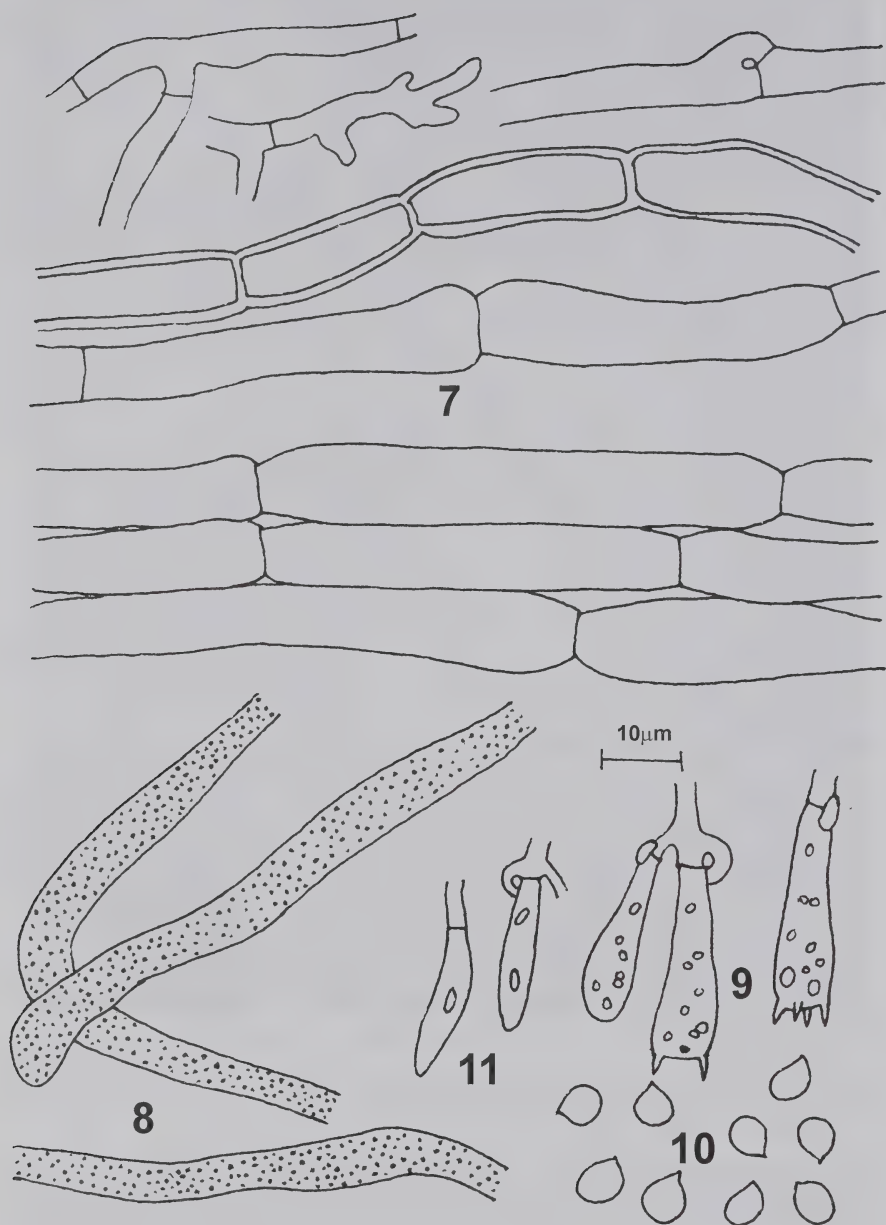
Albatrellus ginnsii can be distinguished from all other *Albatrellus* species, however, by the following combination of features: (i) caespitose small, white, centrally stipitate, basidiocarps with acutely umbonate, circular pilei and stipes with bulbous bases from which 5-6 fused basidiocarps arise; (ii) a white pore surface with 2-3 circular to angular pores per mm; (iii) generative hyphae with simple septa and extremely rare clamp connections; (iv) gloeoplerous hyphae 3.5-7.0 μm in diameter; (v) basally clamped basidia $25-37 \times 8 \mu\text{m}$; (vi) $6-9 \times 4.5-5.5 \mu\text{m}$ basidiospores that are subglobose to ellipsoid, prominently apiculate, weakly amyloid; and (vii) hyaline, thin-walled, smooth cystidioles $15-20 \times 3.5-5.0 \mu\text{m}$.

Most *Albatrellus* basidiomes arise from soil or the litter layer (Ginns 1997). Gilbertson and Ryvarden (1986) stated, "All species have mycorrhizal connections



Figs. 1-6. *Albatrellus ginnsii* (holotype) : **1.** upper surface and hymenial surface of basidiocarps ($\times 1$); **2.** hymenial surface of basidiocarps ($\times 1$); **3.** gloeoplerous hypha ($\times 400$); **4.** context tissue showing parallel arrangement of generative hyphae ($\times 500$); **5.** hymenial layer showing a bisterigmatic basidium ($\times 500$); **6.** basidiospore ($\times 2000$).

with trees” but Stalpers (1992) found “no indication of mycorrhizae.” Mycorrhizae have been synthesized between *Albatrellus ovinus* (Schaeff. : Fr.) Kotl. & Pouzar and *Picea abies* (L.) Karst. roots (Agerer et al. 1996). The fungus described here was found growing on soil adjacent to a large tree of *Ficus benghalensis*. *A. ginnsii* may have a mycorrhizal relationship with this tree species but I have not yet been able to ascertain this aspect.



Figs. 7-11. Microscopic structures from basidiocarp of *Albatrellus ginnsii* (holotype): 7. generative hyphae; 8. gloeoplerous hyphae; 9. basidia; 10. basidiospores; 11. cystidioles.



Map 1. Distribution of the species of *Albatrellus* reported from India

Distribution of different species of *Albatrellus* in India

In India only three species of *Albatrellus* were known, namely, *Albatrellus cantharellus* (Lloyd) Pouzar, *Albatrellus confluens* (Alb. & Schwein. : Fr.) Kotl. & Pouzar and *Albatrellus dispansus* (Lloyd) Canf. & Gilb. (Bilgrami et al. 1991) until I collected the species described here. *A. ginnsii*, therefore, represents the fourth species of *Albatrellus* in India. Among these four species, only *A. ginnsii* has been collected from the plains; the other three species were collected from the northwestern Himalayas between 2005–2215 m. Locality data and a key to the four *Albatrellus* species occurring in India are given below and their distribution is shown above in Map 1.

- A. cantharellus*: Dalhousie (H.P.), on soil among gymnosperm needles, alt. 2036 m.
A. confluens: Mussoorie (U.P.), on soil under *Quercus incana* Roxb. forest, alt. 2215 m.
A. dispansus: Dalhousie & Simla (H.P.), on soil under *Quercus* forest, alt. 2215 m.
A. ginnsii: Calcutta (W.B.), on soil, adjacent to a *Ficus benghalensis* tree, alt. 15 m.

Key to the species of *Albatrellus* occurring in India

1. Each septum of generative hyphae provided with clamp connection, basidiospores weakly amyloid, pileus surface creamish-yellow, pale apricot to pinkish yellow, pores 2–4 per mm *A. confluens*
1. Not with above combination of characters 2

2. Clamp connections absent, pores 4-7 per mm, basidiospores inamyloid *A. cantharellus*
2. Clamp connections extremely rare, pores 2-4 per mm, basidiospores amyloid 3
3. Pileus 2.0-6.0 cm in diameter, surface yellow to yellow tan when fresh, basidiocarps with many petaloid pilei arising from a common base *A. dispansus*
3. Pileus 0.6-1.4 cm. in diameter, surface white when fresh, up to six basidiocarps arising from a common base, pileus circular *A. ginnsii*

Acknowledgement

The author is greatly indebted to Dr. James H. Ginns (Canada) for confirming the identification of the fungus and to Dr. Ginns and Dr. Lorelei L Norvell (USA) for critically reviewing the manuscript.

References

- Agerer R, Klostermeyer D, Steglich W, Franz F, Acker G. 1996. Ectomycorrhizae of *Albatrellus ovinus* (*Scutigeraceae*) on Norway spruce with some remarks on the systematic position of the family. *Mycotaxon* **59** : 289-307.
- Bilgrami KS, Jamaluddin S, Rizwi MA. 1991. Fungi of India (List and References). Today and Tomorrow's Printers and Publishers, New Delhi, India.
- Domanski S, Orlos H, Skirgiello A. 1973. Fungi. Warsaw (English Translation).
- Gilbertson, RL, Ryvardeen L. 1986. North American polypores. Vol. I. Fungiflora, Oslo, Norway.
- Ginns J. 1994. *Albatrellus* (Fungi: Basidiomycota) in Michigan. *Mich. Bot.* **33** : 75-90.
- Ginns J. 1997. The taxonomy and distribution of rare or uncommon species of *Albatrellus* in western North America. *Can. J. Bot.* **75** : 261-273.
- Pouzar E. 1972. Contribution to the knowledge of the genus *Albatrellus* (*Polyporaceae*). I. A conspectus of species of the north temperate zone. *Ceska Mykol.* **26** : 194-200.
- Roy A, De AB. 1996. *Polyporaceae* of India. International Book Distributors, Dehra Dun, India.
- Ryvardeen L. 1976. The *Polyporaceae* of North Europe. Vol. I. Fungiflora, Oslo, Norway.
- Ryvardeen L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora, Oslo, Norway.
- Smith HV, Smith AH. 1973. How to know the non-gilled fleshy fungi. WM. C. Brown Company Publishers, Dubuque, Iowa.
- Stalpers JA. 1992. *Albatrellus* and *Hericiaceae*. *Persoonia* **14** : 537-541.

A new combination in *Lacrymaria* (Agaricales)

VAGNER GULARTE CORTEZ & GILBERTO COELHO

cortezvg@yahoo.com.br

Universidade Federal do Rio Grande do Sul

Programa de Pós-graduação em Botânica

Av. Bento Gonçalves, 9500, Campus do Vale

CEP: 91501-970 Porto Alegre, RS, BRAZIL

Abstract— The genus *Lacrymaria* (*Psathyrellaceae*) is reported for the first time in Brazil. *Psathyrella hypertropicalis* is transferred to *Lacrymaria* based on basidiome morphology and scanning electron microscopy studies (SEM) of the basidiospores. This species is characterized by the velutinate pileus and the verrucose basidiospores 9-12 x 6-8 μm with a well-developed germinal tube.

Key words— Basidiomycota, *Coprinaceae* s.l., *Psathyrellaceae*, *Psathyrella* subg. *Lacrymaria*, Brazil

Introduction

Studies on coprinaceous fungi in Brazil are very scarce (Putzke 1994). Some of the most relevant works on the group in Brazil are those of Alves & Cavalcanti (1996), Pegler (1997), Richardson (2001), Rick (1961), and Stijve & de Meijer (1993). However, the genus *Lacrymaria* Pat. has not been reported in these studies, either as considered an independent genus (Kits van Waveren 1985, Watling 1979, Watling & Gregory 1987) or as a subgenus of the large genus *Psathyrella* s.l. (Singer 1986, Smith 1972, Guzmán et al. 1990, Fouchier 1995).

Studies in molecular systematics have changed drastically the classification of this group of agarics (Hopple Jr. & Vilgalys 1999, Moncalvo et al. 2002), and a new family name – *Psathyrellaceae* (Singer) Vilgalys, Moncalvo & Redhead – was recently proposed by Redhead et al. (2001). In these works, *Lacrymaria* seems to form a well-supported clade within the *Psathyrellaceae*, justifying its generic status.

This paper reports for the first time a species of the genus *Lacrymaria* in Brazil. A new combination is also proposed, based on basidiomata morphology and scanning electron microscopy (SEM) study of the basidiospores.

Materials and Methods

Collected specimens were studied macro and microscopically. Microscopic analysis of the basidioma comprised 25 measurements of each microstructure (except for the basidiospores - 50 measurements), studied under 5% KOH and 1% Congo red solutions. Scanning electron microscopy (SEM) studies were conducted at the Center of Electron

Microscopy of the Universidade Federal do Rio Grande do Sul. The collected material is deposited in the herbarium ICN (Department of Botany, Universidade Federal do Rio Grande do Sul). Additional materials from the herbaria XAL (a topotype) and SP were studied for comparison.

Taxonomy

Lacrymaria hypertropicalis (Guzmán, Band.-Muñoz & Montoya) Cortez, **comb. nov.** FIGURES 1-5

Basonym: *Psathyrella hypertropicalis* Guzmán, Band.-Muñoz & Montoya, Brittonia 40: 229, 1988.

Pileus 58-60 mm in diameter, convex to campanulate; ferruginous brown on disc, pale brown toward the margin; surface dry, velutinous on disc to strigose at margin, which is also covered by appendiculate velar remnants; context thin (up to 2-3 mm), yellowish. **Lamellae** adnexed, somewhat close, blackish gray with a whitish edge, which presents milky droplets when fresh. **Stipe** 115-120 x 13-15 mm, central, cylindrical; yellowish to brownish yellow, with brown fibrils on surface; hollow, with a cottony internal mycelium, flesh brownish; annular zone present on center. **Veil** present both on pileus margin and stipe, in the form of glutinous and blackened fibrils, but not forming a well-developed annulus. **Spore-print** black.

Basidiospores 9-12 x 6-8 (-8.5) μm , ellipsoid to broad-ellipsoid, strongly verrucose and with a thickened wall under light microscopy, dark brown with blackish warts in KOH solution, but readily discolored to pale violaceous when threatened with H_2SO_4 , germ-pore present, wide and projecting. **Basidia** 27-34 x 10-13 μm , clavate, thin-walled, hyaline, bearing four sterigmata. **Pleurocystidia** present, but very scarce and very similar to the cheilocystidia, generally fasciculate in groups of no more than five. **Cheilocystidia** 46-68 (-92) x 9-13 μm , cylindrical with a capitate or subcapitate apex, hyaline, thin-walled, abundant in the gill edge. **Pileipellis** hymeniform, with subglobose and thin-walled 31-44 μm wide hyphae. **Gill trama** regular, composed of thin-walled (8-) 11-19 μm wide hyphae. **Stipitipellis** formed by parallel, hyaline, thin-walled hyphae 4-11 μm . **Caulocystidia** 65-94 x (9-) 11-15 (-17) μm , present in fascicles on stipe surface, very similar to the cheilocystidia but slightly larger. **Clamp connections** present.

Ecology: on soil between grasses, under a *Ceiba speciosa* (A. St.-Hil.) Ravenna ("paineira" - Malvaceae).

Material examined: BRAZIL. Rio Grande do Sul State: Porto Alegre, Universidade Federal do Rio Grande do Sul, V.G. Cortez 036/04, 28.VI.2004 (ICN). MEXICO. Veracruz, E of Cofre de Perote, Ingenio El Rosario, El Revolcadero, 28.VI.1985, G. Guzmán 28852 (XAL – topotype). **Additional specimen examined:** *Lacrymaria lacrymabunda* (Bull.: Fr.) Pat. (as *Hypholoma velutinum* (Fr.) Quél.): UNITED STATES. Iowa: Iowa City, G.W. Martin, 29.IX.1945 (SP 38996; MICH).

Discussion: Guzmán, et al. (1988) described *Psathyrella hypertropicalis* from the subtropical forests of Mexico, and it was defined by the strongly verrucose surface of the basidiospores, 10-12 x 7-7.5 μm , and with a conspicuous germinal tube.

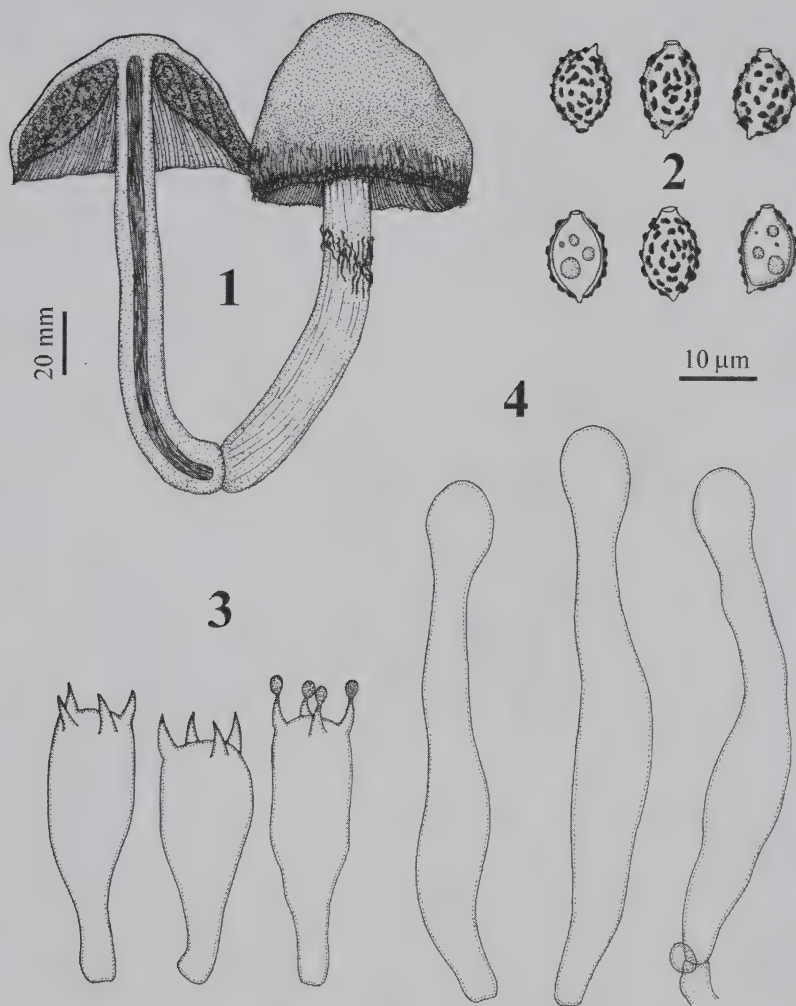


Figure 1-4. *Lacrymaria hypertropicalis*. 1. Habit and section. 2. Basidiospores. 3. Basidia. 4. Cheilocystidia.

Guzmán et al. (1990) recognized two additional varieties: *P. hypertropicalis* var. *microtubulata* Guzmán, Band.-Muñoz & Montoya, with a fibrillose to glabrous pileus, and *P. hypertropicalis* var. *pubescens* Guzmán, Band.-Muñoz & Montoya, with a velutinate pileus. Both varieties are separated from the typical variety for the germinal tube ($0.8\text{--}1.2\text{ }\mu\text{m}$ long for the var. *hypertropicalis* against $0.4\text{--}0.8\text{ }\mu\text{m}$ for the varieties

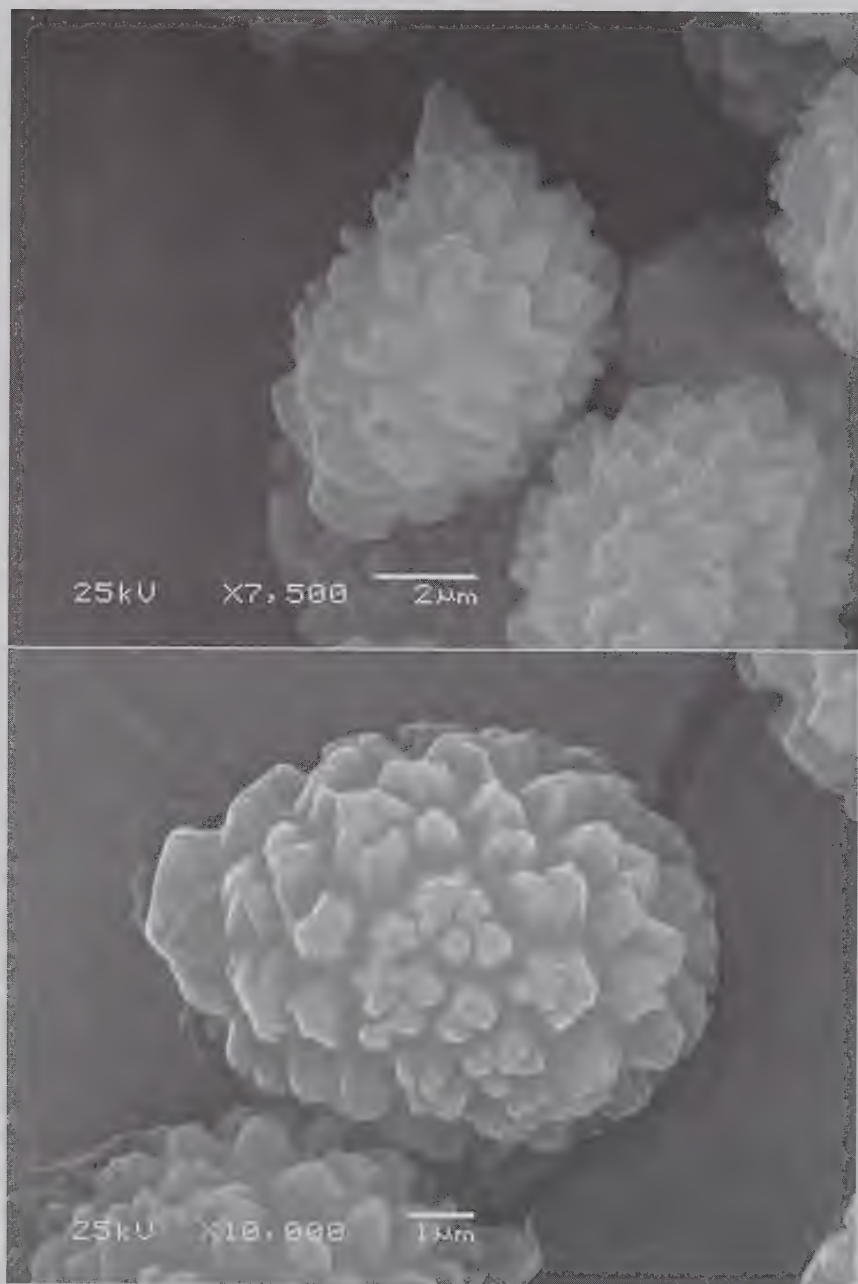


Figure 5. Scanning electron micrographs of the basidiospores of *Lacrymaria hypertropicalis*.

microtubulata and *pubescens*). We are not able to discuss these infra-specific taxa due the scarce Brazilian collected material, but according to the key presented by Guzmán et al. (1990), our collection must to belong to the var. *hypertropicalis* because it presents a germinal tube longer than 0.8 μm and a velutinate pileus.

Based on the basidiome and basidiospore morphology, this species is here transferred to the genus *Lacrymaria*, as it has been circumscribed by Watling (1979) and supported by recent molecular studies (Moncalvo et al. 2002).

The SEM studies revealed a strong ornamentation of the spore wall, in the form of warts (Fig. 5), as Guzmán et al. (1990) presented for *P. hypertropicalis*. This character was used by Guzmán et al. (1990) to separate this and other species (*P. asperospora* (Cleland) Guzmán, Band.-Muñoz & Montoya, *P. pseudovelutina* Guzmán, Band.-Muñoz & Montoya) from the temperate *L. lacrymabunda* (Bull.: Fr.) Pat. (= *L. velutina* (Pers.: Fr.) Konrad & Maubl.).

The Brazilian specimens were firstly identified as *L. lacrymabunda* following Dennis (1970) and Horak (1979). *Lacrymaria lacrymabunda* is common in Europe and North America but apparently not occurs in tropical America, as discussed by Guzmán et al. (1990). According to Guzmán et al. (1990), the reports of *L. lacrymabunda* from Venezuela by Dennis (1970) and from Argentina by Horak (1979) represent *L. hypertropicalis*. With the present report its distribution area is extended to Brazil.

Acknowledgements

Our deep gratitude is expressed to Dr. Gastón Guzmán and Dr. Roy Watling by the critical review of the present work. The authors also are acknowledged to Dr. Rinaldo Pires dos Santos (Department of Botany, UFRGS) and the Center of Electron Microscopy of the Universidade Federal do Rio Grande do Sul (CME/UFRGS) for allowing the SEM studies. The curators of the herbaria XAL (Instituto de Ecología, Xalapa, Mexico) and SP (Instituto de Botânica, São Paulo, Brazil) are acknowledged for the loan of specimens. The senior author thanks to CNPq (Brazil) for financial support.

Literature cited

- Alves MH, Cavalcanti MAQ. 1996. *Coprinaceae* en el campus de la Universidad Federal de Pernambuco. Boletín Micológico 11: 33- 40.
- Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Add. Ser. 3: 1-531.
- Fouchier F. 1995. Le genre *Psathyrella* (Fries) Quélet: flore des espèces européennes et méditerranéennes. Monographies Mycologiques I. Montpellier: Fédération des Associations Mycologiques Méditerranéennes. 98 p.
- Guzmán G, Bandala VM & Montoya L. 1990. Observaciones taxonómicas sobre el género *Psathyrella* subgénero *Lacrymaria* en México y descripción de nuevos taxa (Basidiomycotina, Agaricales). Rev. Mex. Micol. 6: 105-123.
- Guzmán G, Montoya L & Bandala VM. 1988. A new species of *Psathyrella* (Agaricales, Coprinaceae) from Mexico, with discussions on the known species. Brittonia 40: 229-234.
- Hopple Jr. JS, Vilgalys R. 1999. Phylogenetic relationships in the mushroom genus *Coprinus* and dark-spored allies based on sequence data from the nuclear gene coding for the large ribosomal subunit RNA: divergent domains, outgroups, and monophyly. Mol. Phylogen. Evol. 13: 1-19.

- Horak E. 1979. Fungi, Basidiomycetes *Agaricales* y Gasteromycetes Secotioides. Flora Criptogámica de Tierra del Fuego 11 (6): 1-525.
- Kits van Waveren E. 1985. The Dutch, French and British species of *Psathyrella*. Persoonia, Suppl. 2: 1-300.
- Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H & Miller Jr OK. 2002. One hundred and seventeen clades of euagarics. Mol. Phylogen. Evol. 23: 357-400.
- Pegler DN. 1997. The agarics of São Paulo, Brazil. London: HMSO/Royal Botanic Gardens, Kew. 68 p.
- Putzke J. 1994. Lista dos fungos *Agaricales* (Hymenomycetes, Basidiomycotina) referidos para Brasil. Caderno de Pesquisa, Sér. Bot. 6: 1-189.
- Redhead SA, Vilgalys R, Moncalvo JM, Johnson J, Hopple Jr. JS. 2001. *Coprinus* Pers. and the disposition of *Coprinus* species *sensu lato*. Taxon 50: 203-241.
- Richardson MJ. 2001. Coprophilous fungi from Brazil. Braz. Arch. Biol. Technol. 44: 283-289.
- Rick J. 1961. Basidiomycetes Eubasidii in Rio Grande do Sul Brasilia. 5. *Agaricaceae*. Iheringia, Sér. Bot. 8: 296-450.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4 ed. Koenigstein: Koeltz Scientific Books. 981 p.
- Smith AH. 1972. The North American species of *Psathyrella*. Mem. NY. Bot. Gard. 24: 1-633.
- Stijve T, de Meijer AAR. 1993. Macromycetes from the state of Paraná. 4. The psychoactive species. Arq. Biol. Tecnol. 36: 313-329.
- Watling R. 1979. Studies in the genera *Lacrymaria* and *Panaeolus*. Notes from the Royal Botanic Garden of Edinburgh 37: 369-379.
- Watling R, Gregory N. 1987. British Fungus Flora 5: *Strophariaceae* & *Coprinaceae* p.p. Edinburgh: HMSO/Royal Botanic Garden of Edinburgh. 121 p.

A new species of *Vizella* from Australia

JAMES H. CUNNINGTON

James.Cunnington@dpi.vic.gov.au

Department of Primary Industries, Knoxfield Centre
621 Burwood Hwy, Knoxfield, 3180, Victoria, Australia

Abstract—*Vizella philothecae* sp. nov. is described from living leaves of *Philotheca myoporoides* (Rutaceae). It is distinguished from other *Vizella* species by the combination of ascospore size, obovoid shape and absence of a hyaline basal cell. It is known only from a single specimen collected in southeastern Australia.

Key words—*Vizellaceae*, *Entopeltis*, *Eriostemon*

An examination of *Vizella* Sacc. (Ascomycota: *Vizellaceae*) specimens in VPRI (Victorian Department of Primary Industries, Australia) revealed a previously undescribed species on *Philotheca myoporoides* (Rutaceae). It is known only from a single specimen.

Material was mounted in lactic acid, warmed and examined using Nomarski interference contrast microscopy.

Vizella philothecae Cunnington sp. nov.

FIGURES 1–3

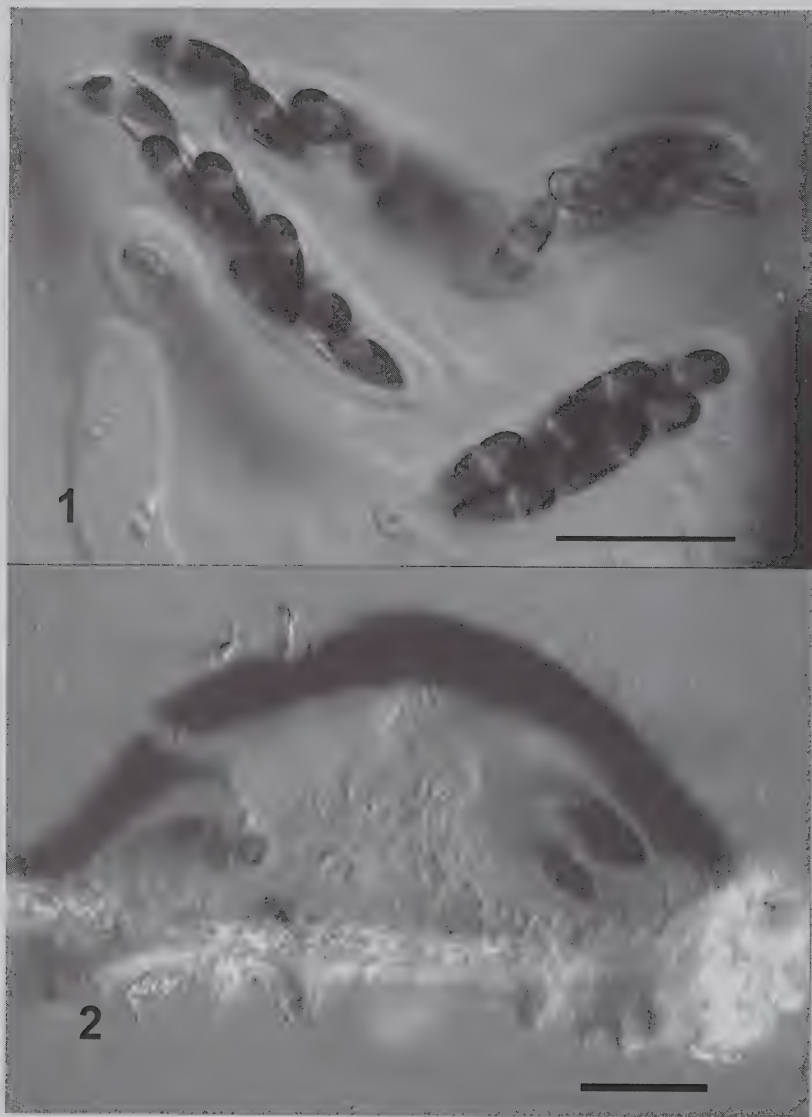
Coloniae superficialiae, epiphyllae, in cuticulae crescentes. Hyphae vitiformes, usque 5 µm latae, hyalini vel pallide brunnei, septis incrassatis et atrobrunnei compositum. Ascumata disciformia, 120–150 µm lata. Asci circum columnam centalem paraphysum radiatim depositi, bitunicati, octospori, cylindrici vel subclavati 35–50 × 11–14 µm. Ascosporae biseriatae, aseptatae, brunneae, obovoideae, 10–13 × 4–5 µm, cum extravitam supra median hyalinum transversum 1–2 µm latum.

Etymology: Referring to the genus of host plant.

Colonies superficial, epiphyllous, growing in the cuticle. Hyphae ribbon-like, up to 5 µm wide, hyaline to pale brown, septa thickened and dark-brown. Ascumata discoid, 120–150 µm wide. Asci arranged radially around a central column of paraphyses, bitunicate, 8-spored, cylindrical to subclavate 35–50 × 11–14 µm. Ascospores biseriatae, aseptate, brown, obovoid, 10–13 × 4–5 µm with a supermedial transverse hyaline band 1–2 µm wide.

TYPUS here designated: On *Philotheca myoporoides* (DC.) M.J.Bayly (Rutaceae), Australia: Victoria, Seven Acre Rock, 22 January 1986, Pascoe, I.G., VPRI 13214 (holotype).

Although *Philotheca myoporoides* (= *Eriostemon myoporoides* DC.) is one of the most widely cultivated native Australian shrubs, only one fungus has been described from



Figs. 1–2. Micrographs of *Vizella philothecae*. **1.** Asci and ascospores. **2.** Ascocarp. Scale bar = 20 μm .

its leaves. *Puccinia eriostemonis* McAlpine was described based on two collections (McAlpine 1906), but has since been found only once (herb. BRIP, DAR and VPRI records).

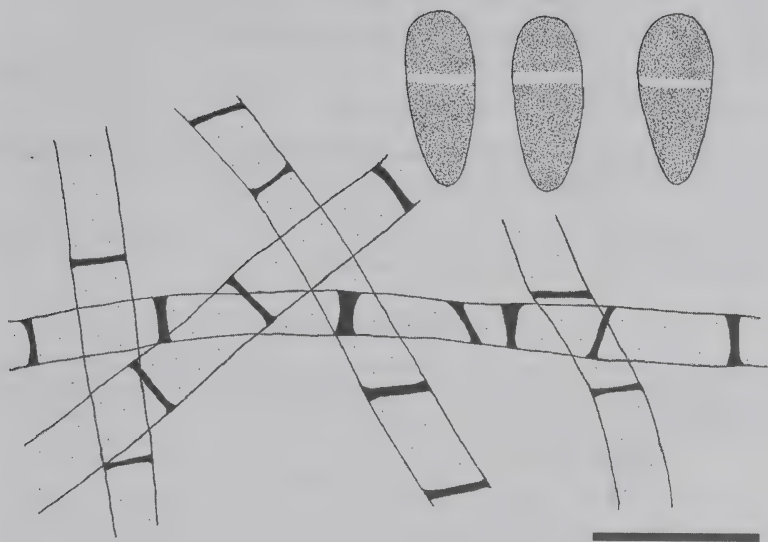


Fig. 3. *Vizella philothecae*. Ascospores and intracuticular hyphae. Scale bar = 10 μ m.

Vizella philothecae is the second fungus to be described from the leaves of *P. myoporoides*, and is the only *Vizella* species known on the *Rutaceae*. It differs in a number of respects from other *Vizella* species found in Australia. *Vizella interrupta* (G. Winter) S. Hughes (synonyms include *V. banksiae* H.J. Swart and *V. banksiae* H.J. Swart) on proteaceous plants, differs in its larger ellipsoid ascospores (Taylor & Crous 1998). The ascospores of *V. xanthorrhoeae* Sivan. & B. Sutton are of a similar size to *V. philothecae*, but are also ellipsoid (Sivanesan & Sutton 1985). *Vizella oleariae* H.J. Swart on *Olearia argophylla* is a common species in southeastern Australia, but differs from the species described here by the hyaline basal cell on the ascospores (Swart 1971). *Vizella philothecae* also differs from the above species by forming hyphae that do not have alternating darkly pigmented and pale cells.

Entopeltis Höhn. was synonymised with *Vizella* by Hughes (1953). Most later authors agreed (Swart 1981, Sivanesan & Sutton 1985), however Arx & Müller (1975) maintained that *Entopeltis* should be used for taxa with one-celled ascospores and the absence of a column of sterile tissue in the centre of the ascumata. Those taxa with two-celled ascospores and a column of sterile tissue would be placed in *Vizella*. *Vizella philothecae* has a mixture of these characters, as does the recently described *V. metrosideri* P.R. Johnst. (Johnston 2000). Thus, *Entopeltis* is regarded here as a synonym of *Vizella*.

The combination of ascospore size, obovoid shape and absence of a hyaline basal cell, distinguishes *V. philothecae* from *Vizella* (including *Entopeltis*) species described in other parts of the world.

Key to *Vizella* species in Australia

1. Ascospores with a hyaline basal appendage. On *Olearia argophylla*..... *V. oleariae*
1. Ascospores without a hyaline basal appendage 2
 2. Ascospores obovoid. On *Philotheca myoporoides*. *V. philothecae*
 2. Ascospores ellipsoid. 3
3. Ascospores $15-16 \times 7-11 \mu\text{m}$. On *Proteaceae*. *V. interrupta*
3. Ascospores $12-14 \times 6-7 \mu\text{m}$. On *Xanthorrhoea*. *V. xanthorrhoeae*

Acknowledgments

I would like to thank Drs. Roger Shivas (Department of Primary Industries, Queensland) and Kevin Hyde (Department of Ecology and Biodiversity, University of Hong Kong) for reviewing the manuscript.

Literature cited

- Arx JA von, Müller E. 1975. A re-evaluation of the bitunicate ascomycetes with keys to families and genera. *Stud. Mycol.* 9: 1-159.
- Hughes SJ. 1953. Fungi from the Gold Coast II. *Mycol. Pap.* 50: 107-110.
- Johnston PR. 2000. *Vizella metrosideri* sp. nov. *N. Z. J. Bot.* 38: 629-633.
- McAlpine D. 1906. *The rusts of Australia: their structure, nature and classification*. Department of Agriculture, Victoria.
- Sivanesan A, Sutton BC. 1985. Microfungi on *Xanthorrhoea*. *Trans. Brit. Mycol. Soc.* 85: 239-255.
- Swart HJ. 1971. Australian leaf-inhabiting fungi. I. Two species of *Vizella*. *Trans. Brit. Mycol. Soc.* 57: 455-464.
- Taylor JE, Crous PW. 1998. *Vizella interrupta*. *IMI Desc. Fungi Bact.* 1350: 1-3.

***Sulcatistroma nolinae* (Calosphaeriales), and its
Phialophora-like anamorph**

ANNETTE W. RAMALEY

awramaley@yahoo.com

7 Animas Place, Durango CO 81301

Abstract—Genera in the *Calosphaeriales* have been found on wood or other fungi growing on wood. A new genus, *Sulcatistroma*, is described from leaves of *Nolina*. The *Phialophora*-like anamorph in culture shows phialidic conidiogenous cell proliferation on appressed mycelium or upright conidiophores of various configurations.

Key words—diatrypoid configuration, percurrent, phialidic, sympodial

Introduction

During the past several years, small collections of an unknown fungus were repeatedly made on dead leaves of *Nolina micrantha* I.M. Johnst. (Agavaceae). This fungus consists of erumpent, discrete, pseudoparenchymatous stromata containing a single layer of several globose ascomata disposed in a diatrypoid configuration. Mature ascomata are filled with periphyses, scarcely visible deliquescent paraphyses, and unitunicate, clavate asci that remain attached during forcible discharge of the 8 allantoid ascospores. Several pyrenomycete families have asci with allantoid ascospores, but the presence of a pseudoparenchymatous stroma, true paraphyses, and asci that remain attached at maturity, limits consideration to the families of the *Xylariales* or *Calosphaeriales*.

These traits are typical of *Diatrype* Fr. (*Diatrypaceae*, *Xylariales*), a well-known genus with nearly 200 representatives listed in Saccardo (Reed & Farr 1993). Some synonymy is cited in this long list, but other species have since been added. Kirk et al (2001) include only 56 species in the genus in agreement with the modern and extensive study of Rappaz (1987) in which 56 species were carefully described, and many additional synonyms discovered and cited. This family and genus with familiar and widespread species seemed the likely place for the fungus from *Nolina*. However, several traits were discordant. One noticeable character separating the *Nolina* fungus from disposition in *Diatrype* is the nature of the paraphyses that are broad at the base and tapering continuously to a more pointed apex, the shape typical of the *Calosphaeriales*. It is a feature easy to overlook unless ascomata are examined prior to maturation of any asci, or phase microscopy is used in viewing somewhat more mature ascomata.

Munk (1957) established the *Calosphaeriaceae* as a separate family for *Calosphaeria* with its unique centrum characteristics—the arrangement of asci at different heights on upright hyphae along with a few long paraphyses. Munk questioned whether a

separate order might be necessary to accommodate this family. Barr (1983) introduced the *Calosphaeriales* with members found on woody substrata, or associated with other fungi on these substrata (Barr 1990). The centrum for the order is described with fasciculate or spicate clusters of asci accompanied by a few paraphyses tapering upward from a broad base. The order includes the *Calosphaeriaceae* and *Graphostromataceae* (Barr et al 1993). As presently constituted, both families contain species previously placed in *Diatrype* or *Valsa*, genera that share allantoid ascospores, stromata, and a woody substratum, but not the unique centrum of the *Calosphaeriales*. The fungus from *Nolina* is not characterized in any existing generic description of fungi included in the order (Barr 1985, Barr et al 1993, Barr 1998). A new genus, *Sulcatistroma*, is therefore proposed.

Materials and Methods

Transverse sections were cut with a sharp razor blade. All measurements were made on fresh material in drops of sterile tap water. Permanent slides were prepared with lactophenol and for some observations, cotton blue was added. Cultures were prepared by suspending a small piece of a stroma containing mature ascomata on the top of a petri plate and allowing ascospore discharge onto potato dextrose agar (PDA, Difco). Cultures were maintained in tubes of PDA. Few ascospores germinated, but isolations of the same description were made from two collections from locations separated by hundreds of miles. To assess growth and appearance of the anamorph Petri plates of malt agar (MA Difco) with added yeast extract, and oatmeal agar (OA Difco) were inoculated and incubated at RT (17–22 C) on a table top with normal daylight fluctuation.

Taxonomy

Sulcatistroma A.W. Ramaley, **gen. nov.**

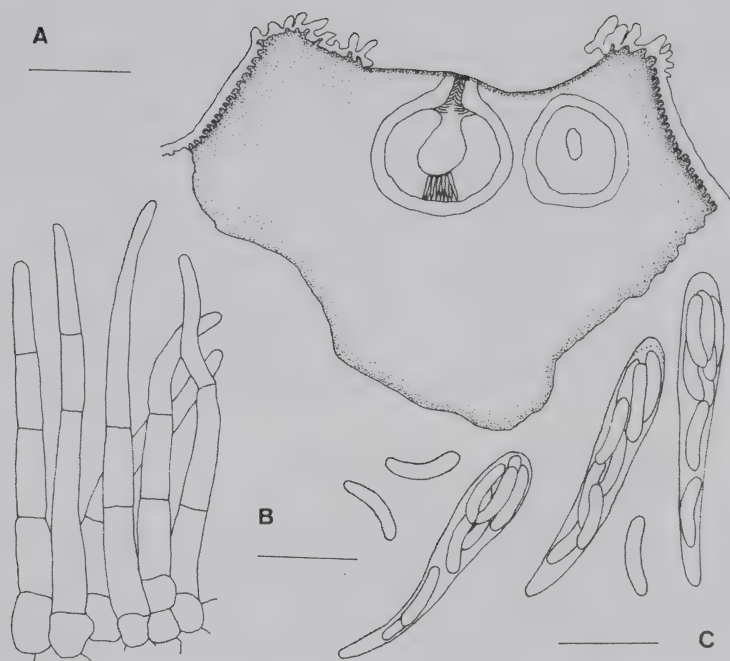
Fructificationes discretæ, erumpentes, pseudoparenchymatæ, stromaticæ. Ascomata in stromatibus inclusa, monostichæ, per ostiola breviter apertæ, distributio diatrypoidea, periphysibus. Asci breviter stipitati, clavati, unitunicati, octospori. Paraphyses numerosæ, bases latæ, contractæ apices versus. Ascosporæ allantoideæ, hyalinae. Species typicus hic designatus: S. nolinae.

Fructifications stromata, discrete, erumpent, pseudoparenchymatous. Ascomata in the stromata in diatrypoid configuration, monostichous, short-ostiolate, with paraphyses; asci unitunicate, clavate, numerous, short stipitate, octosporous; paraphyses broad at base, tapered upwards; ascospores allantoid, hyaline. Type species *S. nolinae*

Sulcatistroma nolinae A.W. Ramaley, **sp. nov.**

FIGURES A–D

Stromata 480–1920 x 480–840 µm superficies brunnea, entostroma plerumque hyaline, interdum brunnea diluta. Ascomata 150–250 µm diam, globosæ, paries plerumque hyalinus, interdum brunneus dilutus. Asci p.sp. 35–44 (–48) x 6.4–8.8 µm. Paraphyses numerosæ, aliquantum longiores quam asci, plerumque 50–60 µm longæ, ad bases ca 4–5 µm latæ, contractæ apices versus. Ascosporæ 9.6–15.2 x 2.4 µm, allantoideæ, aseptatæ, hyalinae, leves.



Figures A-C. *Sulcatistroma nolinae*. Fig. A. Transection of mature, young, moist stroma with diagrammed mature ascoma in mid-longisection. Toothed epidermis of ruptured stomatal cleft on upper surface. Fig. B. Tapered paraphyses before any asci have been delimited. Fig. C. Asci and ascospores. Scale bar for A = 120 μm ; for B, C = 15 μm .

HOLOTYPE here designated: UNITED STATES. NEW MEXICO: Lincoln Co., Valley of Fires, roadside plants, in dead leaves of *Nolina micrantha* IM Johnst., 9 October 2002, Annette Ramaley 0210, BPI 864276. Culture to CBS, ATCC. Paratype: roadside plants, in dead leaves of *Nolina micrantha* IM Johnst., 27 May 1999, Annette Ramaley 9901, UC.

Stromata discrete, erumpent through leaf epidermis, rarely nearly circular, mostly ellipsoid, long axis paralleling length of leaf, 480–1920 $\times$ 480–840 μm ; in transverse section, depending on developmental stage, more or less sulcate around the stomatal cleft when dry, expanding when wet so surface flat when moist, external cell layer brown on upper surface, lighter brown on outermost cell layer of lateral surface of stromata, entostroma pseudoparenchymatous, completely surrounding ascomata, white, in age becoming unevenly pale brown, ostioles entire, emerging separately, not prominent, mostly nearly the same color as stomatal surface but in some collections nearly black from above, hyphae from mature stromata into subtending substrate parenchyma and through stomata in the stomatal cleft midway between coarse longitudinal leaf fibers. *Ascomata* globose, in one layer, wall of elongate *textura angularis*, mostly hyaline, only

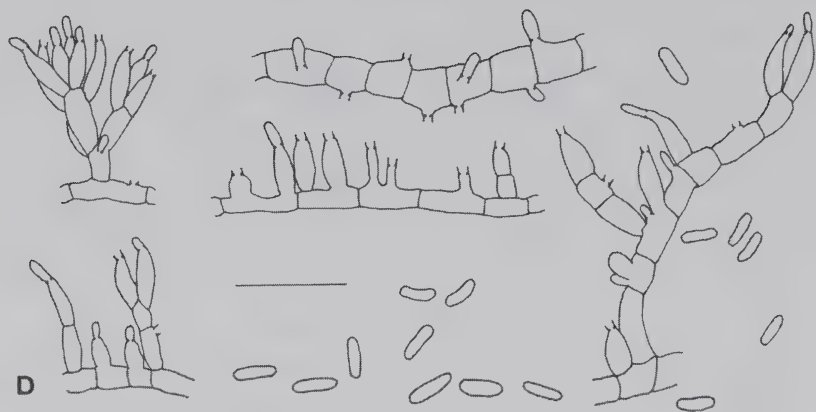


Figure D. *Sulcatistroma nolinae*. Conidia and conidiogenous cell assemblages of cultured *Phialophora*-like anamorph. Scale bar = 15 μm .

occasionally unevenly very pale brown, elongate cells of short neck brown at surface of stroma, 150–250 μm diam, periphyses present, tips brown at surface of stroma, paraphyses tapering from ca 4–5 μm at base, mostly 50–60 μm long, few-(mostly 1–2) septate. Asci clavate, 8-spored, p. sp. 35–44 (–48) $\times$ 6.4–8.8 μm , stipe short, apical ring not observed. Ascospores allantoid with rounded ends, 9.6–15.2 $\times$ 2.4 μm , aseptate, hyaline, smooth. Anamorph *Phialophora*-like

ANAMORPH IN CULTURE: Mycelium white, above and reverse, hyphae hyaline, smooth. Colonies cover Petri plates in 10 days, becoming pale orange from inoculum toward periphery from accumulated conidia. Surface mycelium appressed, free aerial hyphae absent. Conidiogenesis phialidic, conidiogenous cells horizontal in a long series with phialidic apertures directly on cells or raised on cylindric to inflated pegs of various heights, or born on upright conidiophores consisting of an upright conidiogenous cell or an axis of 1–4 cells with 1–4 cells at each junction. Axes up to ca 36 μm tall, even complex axes mostly shorter, cells 2.4–4.0 μm broad, cells in axis may have a lateral phialidic aperture. Many crowded upright axes often originating from one horizontal cell when cultures show this sort of conidiogenous cell proliferation. Phialides with 1 conidiogenous aperture, occasional horizontal phialides with 2, hyaline, smooth, with small periclinal thickening and hyaline, nearly cylindric, colorless collarettes ca 0.5–0.8 μm long. Profuse conidia covering colonies in pale orange masses, 3.2–5.6 $\times$ 0.8–1.6 μm , some increasing in size after formation to at least 8 $\times$ 2.4, nearly cylindric with rounded ends, ellipsoid, or allantoid. This cultured anamorph is designated *Phialophora*-like, but colonies lack the brown coloration of that genus. *Lecythophora* Nannf., cited as the anamorph for *Coniochaeta* (Sacc.) Cooke (Seifert & Gams 2001), has been used for a *Phialophora*-like fungus having numerous conidiogenous cells with simple, lateral, phialidic openings on superficial or submerged hyphae, and lacking the brown pigmentation of *Phialophora*. *Sulcatistroma* cultures show these traits. Although

re-established by Gams & Medlar (1983), *Lecythophora* is often considered a synonym of *Phialophora* (Kirk et al 2001).

Longitudinal fiber bundles bestow rigidity to *Nolina micrantha* leaves that may be up to ca three feet in length. The thick epidermis with stomata restricted to a deep internal epidermal fold, or cleft, between the fiber bundles makes these leaves quite resistant to desiccation in their arid environment. *Sulcatistroma* develops between the longitudinal fiber bundles in parenchyma below and surrounding the stomatal cleft. During dry periods young stomata are deeply sulcate, folded around the stomatal cleft, and firmly attached to the epidermis through stomata. When moist, stomata expand becoming flatter. As stomata grow during moist periods, the stomatal surface is flattened and greatly expanded, the stomatal cleft finally splits at the bottom, and the sides are separated from one another. At maturity, when dry, the upper stomatal surface is still partially or even mostly covered by the flattened sides of the ruptured stomatal cleft. At maturity, when damp, virtually the entire upper surface is exposed via stomatal expansion.

Discussion

Sulcatistroma shares many features with *Diatrype*, but *Diatrype* ascomata are mostly medium sized with colored walls, ostioles are mostly distinguishable from the stromatic surface with short or long beak tips usually more or less sulcate, paraphyses are narrow and cylindric, ascus stipes are generally much extended even before expansion at dehiscence, an ascus ring is generally observable even if small, and ascospores are pale yellow to brown. In addition, cultured anamorphs of the *Diatrypaceae* are quite different from *Sulcatistroma*'s *Phialophora*-like anamorph. Conidiogenous cell proliferation in *Diatrype* and its close relatives is sympodial, percurrent, or a mixture of the two. Conidiophores in cultures may be borne in dark, more or less rudimentary, coelomycetous conidiomata, or on masses of subsolid hyphae in a variety of forms depending on the species under study (Glawe 1983, Glawe & Jacobs 1987, Glawe & Jones 1989, Glawe & Rogers 1981, Glawe & Rogers 1984, Glawe & Rogers 1985, Rappaz 1987). In sharp contrast, conidiogenous cell proliferation varies in the few studied *Calosphaerales*. Hyphomycetous anamorphs with sympodial conidiogenous cell proliferation include that of *Graphostroma* (*Nodulisporium*) which is associated in nature (Pirozynski 1974) and has been cultured (Glawe & Rogers 1985), *Wegelia barbirostris* (Dufour: Fr.) M.E. Barr (*Nodulisporium*-like), and *Pareutypella* (Ju & Rogers 1995) that may or may not be a member of this order. Phialidic conidiogenesis is found in pycnidia of *Pachytrype* (Barr et al 1993), and for two species of *Togninia* (= *Pleurostoma*, Barr et al 1993) that show hyphomycetous growth between *Acremonium* and *Phialophora* (Hausner et al 1992). The phialides of these hyphomycetous anamorphs are more or less upright with slimy drops of conidia accumulating at their tips (Hausner et al 1992). Like these last two species, the *Sulcatistroma* anamorph shows phialidic conidiogenous cell proliferation on variably disposed conidiogenous cells. However, *Sulcatistroma* colonies lack the gray or brown coloration or verruculose hyphae shown in these isolates.

Other stromatic calosphaerialean genera lack the combination of pseudoparenchymatous, discrete stomata with diatrypoid disposition of short-ostiolate ascomata found in

Sulcatistroma. The prosenchymatous stromata of *Graphostroma* and *Pachytrype* are found on wood. In addition, *Graphostroma* stromata are effuse, asci contain a slightly amyloid apical ring, and the anamorph shows sympodial conidiogenous cell proliferation. *Pachytrype* ascomata have colored walls, may be polystichous, are somewhat larger than *Sulcatistroma* ascomata, and the beaks may be extremely long. The anamorph in culture resembles the coelomycete, *Cytospora*. Other members of the order are not truly stromatic.

Acknowledgements

My thanks to Margaret Barr and Jack Rogers for graciously reviewing the manuscript. I also thank Jack Rogers for his reminding me of the existence of *Lecythophora*.

Literature Cited

- Barr ME. 1983. The Ascomycete connection. *Mycologia* 75: 1–13.
- Barr ME. 1985. Notes on the *Calosphaerales*. *Mycologia* 77: 549–565.
- Barr ME. 1998. *Wegelia* a reinstated genus in the *Calosphaerales*. *Cryptogamic Bryl Lichenol* 19: 169–173.
- Barr ME, Rogers JD, Ju Y. 1993. Revisionary studies in the *Calosphaerales*. *Mycotaxon* 58: 529–535.
- Gams W, McGinnis MR. 1983. *Phialemonium*, a new anamorph genus intermediate between *Phialophora* and *Acremonium*. *Mycologia* 75: 977–987.
- Glawe DA. 1983. Observations on the anamorph of *Diatrypella frostii*. *Mycologia* 75: 913–915.
- Glawe DA, Jacobs KA. 1987. Taxonomic notes on *Eutypella vitis*, *Cryptosphaeria populina*, and *Diatrype stigma*. *Mycologia* 79: 135–139.
- Glawe DA, Jones JP. 1989. The anamorphs of *Diatrypella prominens* and *Eutypella sabalina*. *Mycotaxon* 34: 277–281.
- Glawe DA, Rogers JD. 1981. Observations on the anamorphs of six species of *Diatrype* and *Diatrypella*. *Can J Bot* 60: 245–251.
- Glawe DA, Rogers JD. 1984. *Diatrypaceae* in the Pacific northwest. *Mycotaxon* 20: 401–460.
- Glawe DA, Rogers JD. 1985. Conidial states of some species of *Diatrypaceae* and *Xylariaceae*. *Can J Bot* 64: 1493–1498.
- Hausner G, Eyjólfssdóttir GG, Reid J, Klassen GR. 1992. Two additional species of the genus *Togninia*. *Can J Bot* 70: 724–734.
- Ju Y-M, Rogers JD. 1995. *Pareutypella* gen. nov. for two long-ostiolate pyrenomycetes from Taiwan. *Mycologia* 87: 891–895.
- Kirk PM, Cannon PF, David JC, Stalpers, JA. 2001. Dictionary of the Fungi, 9th edition. CAB International.
- Pirozynski KA. 1974. *Xenotypa* Petrak and *Graphostroma* gen. nov., segregates from *Diatrypaceae*. *Can J Bot* 52: 2129–2135.
- Rappaz F. 1987. Taxonomie et nomenclature des *Diatrypacées* à asques octosporés. *Mycologia Helvetica* 2: 285–648.
- Reed CF, Farr DF. 1993. Index to Saccardo's *Sylloge Fungorum* Volumes I–XXVI in XXIX 1882–1972. Contribution No. XXXI of the Reed Library and Herbarium, Darlington, Maryland. Contribution No. 6 from the U.S. National Fungus Collections, Beltsville Maryland. 884 p.
- Seifert KA, Gams W. 2001. The taxonomy of anamorphic fungi. In: Esser K, Lemke PA (eds.) *The Mycota VII: McLaughlin DJ, McLaughlin EG, Lemke PA (volume eds.) Systematics and Evolution Part A*, Springer-Verlag Berlin Heidelberg New York. 366 p.

***Oidium stachytarphetae* on *Stachytarpheta*, emended: new from Australia and New Caledonia**

J. R. LIBERATO¹, I. G. PASCOE², S. D. CAMPBELL³,
J. G. WRIGHT⁴ & R. G. SHIVAS¹

jose.liberato@dpi.qld.gov.au roger.shivas@dpi.qld.gov.au

¹ Department of Primary Industries & Fisheries, Plant Pathology Herbarium
80 Meiers Rd, Indooroopilly, Qld 4068, Australia

² Department of Primary Industries, Knoxfield Centre
Private bag 15, Ferntree Gully delivery Centre, Vic 3156, Australia

³ Tropical Weeds Research Centre, Department of NR&M
PO Box 18, Charters Towers, Qld 4820, Australia

⁴ Plant Protection Service, Secretariat of the Pacific Community
Private Mail Bag, Suva, Fiji Islands

Abstract — Reexamination of *Oidium stachytarphetae*, the only powdery mildew recorded with *Stachytarpheta* as host, supports its placement in *Oidium* subg. *Pseudoidium*. Data from the first reported specimens from Australia and New Caledonia supply additional information for an emended description of *O. stachytarphetae*.

Key words — *Erysiphaceae*

Introduction

Snakeweeds (*Stachytarpheta* spp., *Verbenaceae*) are clumping perennial plants with rather tough, branched stems and woody roots. They are native to the tropical Americas, and eight species have become so common as to be considered weeds in Pacific tropical regions. Four snakeweeds are found in Queensland, Australia (*Stachytarpheta cayennensis* (Rich.) Vahl, *S. jamaicensis* (L.) Vahl, *S. mutabilis* (Jacq.) Vahl, and *S. urticifolia* Sims). They were introduced as garden plants from where they have spread and become serious weeds along coastal Queensland. Snakeweeds are abundant along roadsides, neglected areas, and pastures as well as in sugar cane plantations (Land Protection 2003).

Powdery mildews infecting *Stachytarpheta* spp. from Australia and New Caledonia were sent for identification to the Queensland Department of Primary Industries and Fisheries, Plant Pathology Herbarium in 2004. These specimens, which were found to belong to the genus *Oidium* had “pseudoidium-type” conidiophores with solitary conidia produced at the conidiophore apices.

Only one powdery mildew species, *Oidium stachytarphetae*, has been reported on *Stachytarpheta* (Braun 1987). Yen (1966) described *O. stachytarphetae* as having “euoidium-type” conidiophores in which the conidia are produced in chains. However,

Yen's written description is ambiguous and the associated drawings clearly indicate a *Pseudoidium*. Examination of the *O. stachytarphetae* type specimen (PC Yen MS 660) revealed that its "pseudoidium-type" conidiophores place it in *Oidium* subg. *Pseudoidium*. As conidiophore type is a very important feature of powdery mildew taxonomy, we provide an emended description of *O. stachytarphetae* to prevent future taxonomic confusion.

Taxonomic Description

Oidium stachytarphetae J.M. Yen emended

Figs. 1-6

White superficial colonies, with abundant sporulation, developed amphigenously on leaves and shoots. Superficial *hyphae* branched, septate, 3.5-9 μm wide, hyaline, smooth, mycelial appressoria lobed. *Conidiophores* produced from the external mycelium, cylindrical, hyaline, smooth, 44-94 x 6-11 μm , 0-2 septate, foot-cells cylindrical, straight, 19.5-36 x 6-11 μm , followed by 0-2 often shorter cells. *Conidia* produced singly at the apex of the conidiophores, subcylindric to cylindric, or ellipsoid, 24-68 x 10-24 μm , aseptate, hyaline, smooth. Germ tubes, one at an end of the spore, moderately short (up to 1.5 x the length of the conidium), ending in a lobed appressorium. *Teleomorph* not found.

Habitat: on living shoots and leaves of *Stachytarpheta* spp.

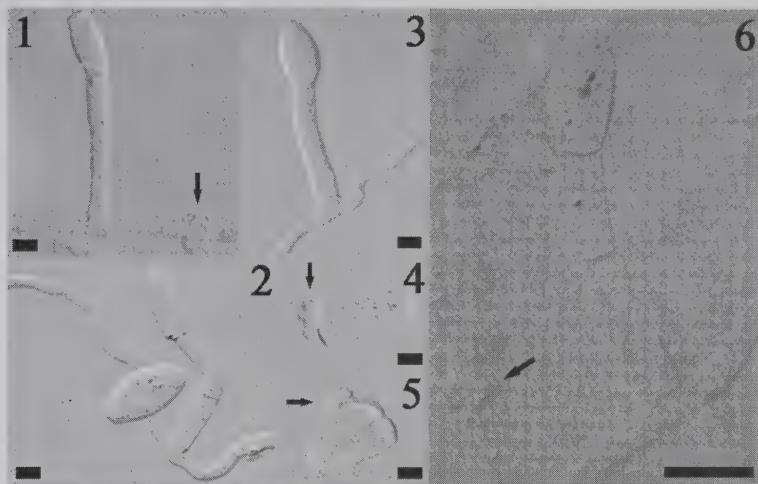
Distribution: Australia, New Caledonia and Singapore.

SPECIMENS EXAMINED – SINGAPORE, Jurong, on *Stachytarpheta indica* (L.) Vahl., 2 Jan 1966, J.M. Yen (**HOLOTYPE**: herbarium PC – Yen MS 660); AUSTRALIA, Queensland, Townsville, Bluewater, on *Stachytarpheta jamaicensis* (L.) Vahl, 12 Jul 2004, S. Campbell (BRIP 45027); Thursday Island (10 35'S 142 13'E), on *S. jamaicensis*, 30 May 1999, A.A. Mitchell (BRIP 26464); Bamaga (10 53'S 142 23'E), on *S. jamaicensis*, 29 May 1981, J.L. Alcorn (BRIP 10722); Thornton Beach (16 10'S 145 26'E), on *Stachytarpheta* sp., 02 Oct 1979, J.H. Simmonds (BRIP 13086); Cooktown (15 28'S 145 15'E), on *S. jamaicensis*, 07 Sep 1977, J.H. Simmonds, (BRIP 12384). NEW CALEDONIA, Goyetta, on *Stachytarpheta urticola* Sims, 02 Sep 2003, J.G. Wright (BRIP 45065).

Discussion

The two recently collected specimens (BRIP 45027 and BRIP 45065) of *Oidium* on *Stachytarpheta* from Australia and New Caledonia and four other herbarium specimens were identified as *O. stachytarphetae*. This is the first reported occurrence of *O. stachytarphetae* from New Caledonia. A search of the powdery mildews on *Stachytarpheta* in the Australian Plant Disease Database (<http://npdd.nre.vic.gov.au/ihd/nre/research.htm> on 03 Aug 2004) yielded 12 records identified as *Oidium* sp. and two as *O. stachytarphetae*. These Australian records have not been published until now.

Erysiphe is the teleomorph name reserved exclusively for the sexual stages of *Oidium* with "pseudoidium-type" conidiophores (Braun 1999, Braun et al. 2002). Although the teleomorph of *O. stachytarphetae* has not been found it is likely to belong to *Erysiphe*.



Figs 1-6. *Oidium stachytarphetae*. **Fig 1-3, 6.** Pseudoidium-type conidiophore with conidium produced singly at the apex and lobed hyphal appressoria (arrowed). **Figs 4-5.** Subcylindric to cylindric conidia with germ tube and multilobed appressoria (arrowed). **Figs 1-5.** BRIP 45065 (Bar = 10 µm) and **Fig 6.** Holotype (Bar = 20 µm).

Acknowledgements

The authors acknowledge the herbarium PC for specimen loan and thank Dr R.W. Barreto (Federal University, Viçosa, Brazil) and Dr U. Braun (Martin-Luther-Universität, Germany) who kindly reviewed the manuscript. J. R. Liberato acknowledges financial support from the Brazilian Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Literature Cited

- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). Beih. Nova Hedwigia 89: 1-700.
- Braun U. 1999. Some critical notes on the classification and the generic concept of the *Erysiphaceae*. Schlechtendalia 3: 48-54.
- Braun U, Cook RTA, Inman AJ, Shin HD. 2002. The taxonomy of the powdery mildew fungi. Pp. 13-55 in Bélanger RR, Bushnell WR, Dik AJ, Carver TLW (Eds.) The powdery mildews: a comprehensive treatise. APS Press, St. Paul.
- Land Protection. 2003. Department of Natural Resources, Mines and Energy of Queensland. Snakeweed and its control (*Stachytarpheta* spp.) 2p. (Facts. Pest series). Available online at: <http://www.nrme.qld.gov.au/factsheets/pdf/pest/PP52.pdf>.
- Yen JM. 1966. Étude sur les champignons parasites du Sud-Est asiatique. V. Note sur quelques espèces d'*Oidium* de Malaisie. Rev. Mycol. 31: 281-310.

Two *Microbotryum* species from the Himalayas

ANDRZEJ CHLEBICKI

chlebick@ib-pan.krakow.pl

Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46
PL-31-512 Kraków, Poland

MARKÉTA SUKOVÁ

marketa.sukova@nm.cz

Mycological Department, National Museum, Václavské nám. 68
CZ-115 79 Praha 1, Czech Republic

Abstract—Two smut fungi are noted from the Himalayas: a new species, *Microbotryum bardanense* on *Silene moorcroftiana*, and *Microbotryum violaceum* on *Dianthus Jacquemontii*.

Key words—SEM teliospore morphology, hybrid, India

Introduction

Taxonomic and nomenclatural problems of the genus *Microbotryum* Lévl. were recently published by Vánky (1998, 2004). According to Almaraz et al. (2002), who investigated the ITS rDNA region of *Microbotryum*, *Sphacelotheca* de Bary and *Ustilago* (Pers.) Roussel, the genus *Microbotryum* is monophyletic and restricted to *Caryophyllaceae*. At present this genus consists of 15 species. However, the taxonomy, nomenclature and problems in species delimitation within the genus are still not resolved satisfactorily (Vánky 2004). During a Himalaya expedition we found smuts similar to *Microbotryum violaceo-irregulare* (Brandenb. & Schwinn) G. Deml & Oberw. on *Silene moorcroftiana* Benth., and *Microbotryum violaceum* (Pers.) G. Deml. & Oberw. s. lato on *Dianthus Jacquemontii* Edgew. & Hook.f. So far these plants have not been mentioned in the world literature as hosts for smut fungi. *Microbotryum violaceo-irregulare* was previously reported from Austria, Germany, Slovakia and Switzerland (Brandenburger & Schwinn 1971, Denchev 1994). Our material of *Microbotryum violaceum* belongs to Group 2 of Durrieu and Zambettakis (1973), named *M. violaceum* var. *silenes-nutantis* (DC. ex Liro) Durrieu & Zambett. (nom. inval., Art. 33.2) and placed by Denchev in *M. violaceum* var. *violaceum* (Denchev & Sharkova 1997). To date, only *Microbotryum nepalense* (Liro) Vánky [= *Ustilago nepalensis* Liro, *Melanopsichium nepalense* (Liro) Zundel, *Bauhinus nepalensis* (Liro) Denchev] was mentioned from the Himalayas (Liro 1924). Some information on fungi from this area was published by Mundkur (1944), and Zundel (1953), as well as by Paul and Sharma (2003). Physiological forms

of *Microbotryum*, connected with certain host plant species were considered by Liro (1924) as separate species. However other mycologists accepted only morphologically well characterized species. The concept of Liro (1924), confirmed recently by Begerow et al. (2004), and Putten et al. (2005), indicates intimate correlation between the parasites and their hosts.

Material and Methods

Dried teliospores were rehydrated in lactophenol by gently heating to boiling point and measured under an Olympus BX-51 light microscope (LM) with an oil immersion lens, at a magnification of 1000x. Thirty spores of each specimen were measured. For scanning electron microscope (SEM) studies, dried spores were coated with gold, c. 20 nm, and photographed using a FEI Quanta 200 scanning electron microscope. Warts, ridges, meshes and muri were measured on SEM pictures. Host plants were identified on the basis of the Flora of Ladakh (Kachroo et al. 1977). Specimens collected during the expedition in the Himalayas (2004) are deposited in KRAM (W. Szafer Institute of Botany in Kraków), PRM (National Museum in Prague) and HUV (Herbarium Ustilaginales Vánky, Gabriel-Biel-Str. 5, D-72076 Tübingen, Germany). The specimen of *Microbotryum bardanense* was collected in India, Jammu and Kashmir state, Himalaya Mts., western part of the mountains near the village Bardan, ca 20 km S of Padum, N 36° 22' 12" E 76° 54' 29", in an alpine meadow, 3888 m elev., 9 July 2004, on *Silene moorcroftiana*, KRAM F 54962, PRM 907124, HUV 21088. The further species, *M. violaceum*, was collected in the same locality, 8 July 2004 on *Dianthus jacquemontii*, KRAM F 54963, PRM 907125, HUV 21089.

Results

Microbotryum bardanense Chleb. & Suková, sp. nov.

Figs. 1A, 2

Diagnosis: Sori in antheris evolutis, massa sporarum brunnea, pulverea. Sporae globosae 5.2-7.3 (5.96) μm diam., episporio brunneo, sub SEM verrucoso, verrucis obtusis vel subacutis, partim reticulato-conjunctis. Ocella reticuli plus minusve regulares, (0.95)1-1.3 μm diam., 4-5 per sporis diametro, verrucis 0.55 μm altis, sparsis v. aggregatis, costis usque ad 0.16 μm altis, saepe confluentibus. Ab Ustilagine violaceo-irregulare structura episporii, ocellis 4-5 per sporis diametro discrepat.

Hab.: In antheris *Silenes moorcroftianae* Benth.

Holotype here designated: India, Jammu and Kashmir state, Himalaya Mts., western part of the mountains near the village Bardan, ca 20 km S of Padum, N 36° 22' 12", E 76° 54' 29", in an alpine meadow, 3888 m elev., 9 July 2004, on *Silene moorcroftiana*, coll. A. Chlebicki, KRAM F 54962, isotypes in PRM 907124 and HUV 21088.

Etymology: The specific epithet refers to the locality in the Himalayas near Bardan monastery.

Description: Sori in the anthers (Fig. 2), spore mass brown, powdery. Spores (Fig. 1A) globose, 5.2-7.3, median (5.96) μm in diameter, irregularly and incompletely reticulate with very prominent, subacute or broadly rounded warts (up to 0.55 μm high), sparse or aggregated, connected by up to 0.16 μm high ridges, but often also confluent. Meshes of reticulum 4-5 per spore diameter, (0.95-)1-1.3 μm in diameter.

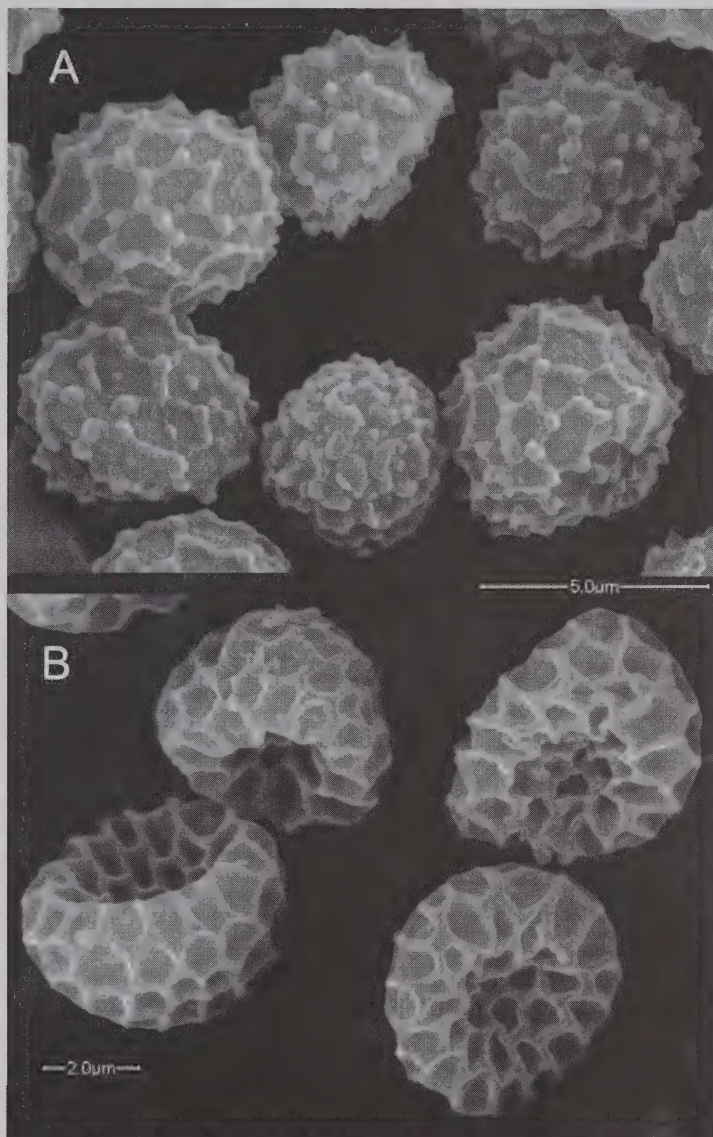


Fig. 1. A - spores of *Microbotryum bardanense* on *Silene moorcroftiana* (type, KRAM F);
B - spores of *Microbotryum violaceum* s. lato on *Dianthus Jacquemontii* (KRAM F).

Distribution. On *Caryophyllaceae*: *Silene moorcroftiana*, India. Known only from the type locality.

Comments: *Microbotryum bardanense* is similar to *M. violaceo-irregulare* but differs in the shape of warts and smaller number of meshes per spore diameter.

Microbotryum violaceum (Pers.) G. Deml & Oberw. 1982: 353 (s. lato).

Description: Sori in the anthers. Spores (Fig. 1B) globose, 5.1-7.1, (median 6.48) μm in diameter, violet, wall reticulate, 5-7 meshes per spore diam., meshes deep, mostly polygonal (0.5-)0.65-1.03(-1.2) μm in diameter, muri (0.18-)0.22-0.3(-0.33) μm high, in median view with rounded edges.

Host range: *Microbotryum violaceum* was noted on many host genera of *Caryophyllaceae*, including *Dianthus* (Vánky 1994, 2004, Denchev & Sharkova 1977).

Comments: The spores of the specimen from the Himalayas are somewhat smaller than those of the species cited by Vánky (1994). It is possible that it represents a separate, host specific taxon.

Discussion

It is possible that species in the genus *Microbotryum* can hybridize. No doubt the process of "hybridization" creates problems for taxonomists. As we know, speciation is a continuous process – the evolutionary formation of new kinds of organisms. Such phenomena are common in nature. Hybridization and parasexual cycles have been detected in many fungi, i.e. Ascomycetes, Basidiomycetes and anamorphs (Caten 1980, Tsai et al. 1994, Clay & Schardl 2002). Ultrastructural characters observed in SEM were often used in taxonomy (Heywood 1971). Intermediate characters of spore ornamentation, and many other characters (see Stace 1989), can be recognized as a sign of hybridization. It is possible that reticulate-spored taxa such as *M. violaceum* s. lato can hybridize with verruculose-spored species (i.e. *M. violaceo-verrucosum* (Brandenb. & Schwinn) Vánky). According to Vánky (personal inform.) *M. violaceo-irregulare* could be a result of such a hybridization. The Himalayan taxon, *M. bardanense*, may also be of similar origin. In both mentioned taxa, meshes and muri are intermediate between reticulate *M. violaceum* and verruculose *M. violaceo-verrucosum*. The ornamentation of spores of the Himalayan taxon is very variable (Fig. 2). The muri are longer and more distinct than in typical *M. violaceo-irregulare*. Also, the meshes are more distinct than in *M. violaceo-irregulare*. Apart from the spores resembling *M. violaceo-irregulare*, there also were spores observed with reticulate ornamentation similar to that of *M. violaceum* as well as verruculose ornamentation similar to *M. violaceo-verrucosum*. A question remains regarding the taxonomic position of the hypothetical parent taxa. Only two taxa of *Microbotryum*, *M. bardanense* and *M. violaceum* s. lato, were present in the type locality. Examination of this taxonomic problem will be the subject of further molecular investigation.

Acknowledgements

We thank Dr. Kálmán Vánky and Dr. Lori M. Carris for valuable comments on the first draft of our manuscript, and Dr. Mirko Svrček for correcting the Latin. Financial support within Project No. 2 P04F 066 28 awarded by the Ministry of Science and Information Society Technologies (Poland), and a grant of the Ministry of Culture of the Czech Republic (Project No. MK00002327201) is gratefully acknowledged. Dr. Lori M. Carris gave assistance with English.



Fig. 2. Sori of *Microbotryum bardanense* in the anthers of *Silene moorcroftiana* (type), scale bar = 2 cm

Literature cited

- Almaraz T, Roux C, Maumont S, Durrieu G. 2002. Phylogenetic relationships among smut fungi parasitizing dicotyledons based on ITS sequence analysis. *Mycol. Res.* 106(5): 541-548.
- Begerov D, Göker M, Lutz M, Stoll M. 2004. On the evolution of smut fungi on their hosts. In: Agerer, Piepenbring & Blanz (eds), *Frontiers in Basidiomycete Mycology*.
- Brandenburger W, Schwinn FJ. 1971. Oberflächenstrukturen der Sporen des Antherenbrandes der Caryophyllaceen im Raster-Elektronenmikroskop. *Nova Hedwigia* 22: 879-895.
- Caten CE. 1980. Parasexual processes in fungi, p. 73-95. In K Gull, and SG. Oliver (ed.), *The fungal nucleus*. Cambridge University Press, Cambridge, United Kingdom.

- Clay K, Schardl C. 2002. Evolutionary origins and ecological consequences of endophytic symbiosis with grasses. *The American Naturalist* 160: 99-127.
- Deml G & Oberwinkler F. 1982. Studies in Heterobasidiomycetes, Part 24. On *Ustilago violacea* (Pers.) Rouss. from *Saponaria officinalis* L. *Phytopathol. Z.* 104: 345-356.
- Denchev C. 1994. Occurrence of *Microbotryum violaceo-irregulare* and *M. violaceo-verrucosum* (*Ustilaginales*) in Austria. *Verh. Zool.-Bot. Ges.* 131: 75-78.
- Denchev C & Sharkova S. 1997. Taxonomic revision of *Microbotryum* (*Ustilaginales*) on *Dianthus*. *Phytologia Balcanica* 3(1): 105-112.
- Durrieu G, Zambettakis Ch. 1973. Les *Ustilago* parasites des Caryophyllacées, apports de la microscopie électronique. *Bull. Soc. Mycol. France* 89(3-4): 283-290.
- Heywood VH. 1971. Scanning electron microscopy: systematic and evolutionary application. Academic Press, London and New York
- Kachroo P, Sapru BL, Dhar U. 1977. Flora of Ladakh. Bishen Singh Mahendra Pal Singh, Dehra Dun, 172 pp.
- Liro JI. 1924. Die Ustilagineen Finnlands I. *Ann. Acad. Sci. Fenn. Ser. A.* 17(1): 1-636.
- Mundkur BB. 1944. Fungi of the Northwestern Himalayas: *Ustilaginales*. *Mycologia* 36: 286-293.
- Paul YS, Sharma RC. 2003. Mycoflora of Northwest Himalayas. Himal Pradesh, Dehra Dun, International pp. 244.
- Putten Van WF, Biere A, Van Damme MM. 2005. Host-related genetic differentiation in the smut fungus *Microbotryum violaceum* in sympatric, parapatric and allopatric populations of two host species *Silene latifolia* and *S. dioica*. *J. Evol. Biol.* 18: 203-212.
- Stace CA. 1989. Plant taxonomy and biosystematics. Edward Arnold, Cambridge
- Tsai HF, Liu JS, Staben C, Christensen MJ, Latch GCM, Siegel MR, Schardl CL. 1994. Evolutionary diversification of fungal endophytes of tall fescue grass by hybridization with *Epichloë* species. *Proceedings of the National Academy of Sciences of the USA* 91: 2542-2546.
- Vánky K. 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, 570 pp.
- Vánky K. 1998. The genus *Microbotryum* (smut fungi). *Mycotaxon* 67: 33-60.
- Vánky K. 2004. Anther smuts of *Caryophyllaceae*. *Taxonomy, nomenclature, problems in species delimitation. Mycologia balcanica* 1: 189-191.
- Zundel GL. 1953. The *Ustilaginales* of the world. Pennsylvania State Coll. School Agric. Dept. Bot. Contrib. 176: 1-410.

***Tuber furfuraceum* sp. nov. from Taiwan**¹HUNG-TAO HU ²YUN WANG *

wangy@crp.cri.nz

¹Department of Forestry, National Taiwan University, 106 Taipei, Taiwan²Institute of Applied Ecology, Academia Sinica
72 Wenhua Road, Shenyang 110015, Liaoning, China

Abstract—A new truffle species, *Tuber furfuraceum*, collected from Nan-tou County, Taiwan is described and illustrated. This new species is apparently mycorrhizal with *Cyclobalanopsis glauca*. The relationship of the new species to other closely related species is discussed.

Key words—Ascomata, ascospore, taxonomy

In autumn 2002, when the senior author harvested Taiwanese black truffles, *T. formosanum* H.T. Hu (Hu 1992), from his truffière, a brown fruiting body among the black ones attracted his attention. In August, 2003, nine fruiting bodies of this species were found again from the rhizosphere of *C. glauca* in the same truffière. Apparently, this is a local species associated with *Cyclobalanopsis glauca* (Thunb.) Oerst. that was present there before the truffière was established with *T. formosanum*-inoculated seedlings. We describe below a new *Tuber* species closely related to *Tuber huidongense* Y. Wang (Wang & He 2002).

Tuber furfuraceum* H.T. Hu & Y. Wang sp. nov.*Figures 1–4**

Ascomata subglobosa, usque ad 5–25 mm in diam, brunnea, glabrata. Peridium 340–480 µm crassum, luteofurfuraceum stratis dubus: epicutis 170–270 µm crassa, pseudoparenchymatis, subcutis 170–210 µm crassa, prosenchymatis. Gleba solida, brunnea, venis albis. Asci sporis (1)2–4(5), subglobosi vel irregulares, (50–)55–69 (–95) x (42–)43–569–67 µm. Ascosporae ellipsoideae, (23–)25–46 x 14–27 µm, spinoreticulatae. Habitat in ad terrata sub *Cyclobalanopsis glauca* (Thunb.) Oerst., alt. 1200m. Holotypus hic designatus: H.T. Hu 0201, Taiwan: Nan-Tou.

Etymology: the specific epithet refers to the scurf peridial surface of this species.

Ascomata globose to ellipsoidal, slightly lobed, brown, 5–25 mm in diameter, rough with patches or stripes covered with a sort of yellowish scurfy substance, no hairs, and solid. **Odour** slight, not distinctive. **Peridium** 340–480 µm thick, two layers (Fig. 1); the outer layer complex, 170–270 µm thick, with a crust of subglobose brown, thick-walled

*Corresponding author

cells, up to 22 μm , with 2 μm thick, below the outermost layer is pseudoparenchymatic layer, the cells more or less globose, 10–20 μm in diameter; the inner layer 170–210 μm thick, composed of colourless, interwoven hyphae, 3–4 μm in diameter with swollen cells, up to 10 μm , gradually merge into the gleba tissue. **Gleba** whitish when young, becoming brown when mature; veins distinct, whitish, derived from many points on the periphery, branched, some of them not entirely closed; inter-ascal hyphae next to the peridium, composed of colourless, interwoven hyphae, 3–4 μm in diameter and otherwise swollen, thin-walled cells, up to 20 μm (Fig. 2). **Asci** (1-) 2–4 (-5) spored with a stalk, up to 45 μm long; young asci with no ascospores mostly subglobose, colourless; 1-spored asci ovoid or oblong, (52-) 55–59 (-63) $\times$ 43 (-48) μm ; 2-spored asci oblong, (50-)58–63(-67) $\times$ 53(-59) μm ; 3-spored asci obpyriform to ampulliform, (52-)62–66(-95) $\times$ (42-)49–52(-67) μm ; 4-spored asci oblong or ampulliform, (53-)64–68(-78) $\times$ (46-)50–54 (-61) μm diam; and 5-spored asci ampulliform, (57-)65–69(-74) $\times$ (46-)51–56(-58) μm ; the wall up to 4 μm thick. **Ascospores** ellipsoid; dimension ranges (excluding ornamentation) are (36-)43–46 $\times$ 23–27 μm (1-spored), (34-)36–38(-40) $\times$ 19–23 μm (2-spored), 29–33 $\times$ 19–21 μm (3-spored); (25-)29–34 $\times$ 17–19 μm (4-spored); and (23-)26–30(-34) $\times$ 14–16 μm (5-spored) with a length-width ratio of (1.3-)1.7(-2.3) and wall thickness of 2, dark brown (pale brown in younger spores), spiny-reticulate with bent points, irregular in mesh shape and size, meshes numbering (3-)4–5(-7) down and 3–5 across the spore with ornamentation up to 5 μm tall (Figs. 3–4).

Holotype here designated: Nan-tou C., Taiwan, alt. 1200 m, under *Cyclobalanopsis glauca* - December, 2002, H.T. Hu 0201 (Herbarium of Forestry Department, National Taiwan University, Taipei, Taiwan); isotype - H.T. Hu 0201 (OSC).

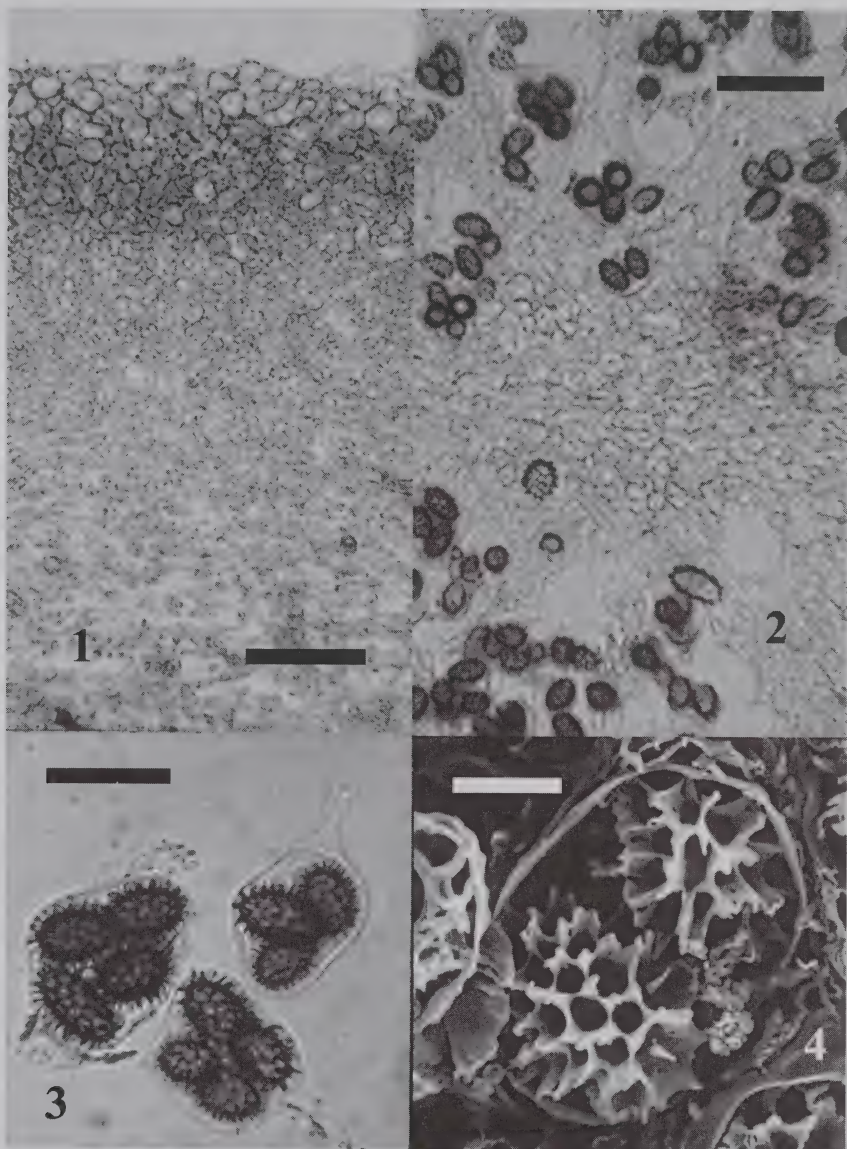
Tuber furfuraceum resembles *T. huidongense* but differs in its yellowish, scurfy peridial surface and larger but narrower ascospores (Figs. 3–4). Its ascospore length: width ratio—(1.3-)1.7(-2.3)—contrasts with that of *T. huidongense*—1.1–1.4. It is interesting that even as the Taiwanese black truffle, *T. formosanum*, resembles *T. indicum* Cooke & Massee and other black truffles from SW China (Yamanaka et al. 2001), *T. furfuraceum* (from Taiwan) and *T. huidongense* (from China) fruit in the same habitats as their black Taiwanese and Chinese black truffle associates. This supports the morphological evidence that *T. furfuraceum* and *T. huidongense* share the same phylogenetic relationships as do the Taiwanese and Chinese black truffles.

Acknowledgements

We are grateful to Dr James Trappe and Dr Michael Castellano for their helpful comments on the manuscript. The senior author thanks the Institute of Applied Ecology, Academia Sinica for sponsorship of this study.

References

- Hu HT. 1992. *Tuber formosanum* sp. nov. and its mycorrhizal associations. J. Exp. For. National Taiwan University, **6**: 79–86. (in Chinese) Yamanaka K, Namba K, Tajiri A. 2001. Asian black truffles. In Science et Culture de la Truffe. Actes du V^e Congrès International, 4 au 6 mars 1999, Aix-en-Provence, France. pp. 117–120.
- Wang Y, He XY. 2002. *Tuber huidongense* sp. nov. from China. Mycotaxon, **83**: 191–194.



Figs. 1-4. *Tuber furfuraceum* (Hu 0201). **Fig. 1.** Section of peridium showing the two layers (bar = 70 μm). **Fig. 2.** Section of gleba showing the ascial tissues, composed of swollen, thin-walled cells, up to 20 μm (bar = 80 μm). **Fig. 3.** Asci and ascospores (bar = 50 μm). **Fig. 4.** Ascospores (ESM, bar = 10 μm).

**A new species and a new record of *Anthracoidea*
(*Ustilaginales*) from China**LIN GUO¹ & SHENGRONG WANG²

guol@sun.im.ac.cn

¹Key Laboratory of Systematic Mycology & Lichenology
Institute of Microbiology, Chinese Academy of Sciences, Beijing 100080, China

wangsr@gsau.edu.cn

²Department of Plant Pathology, College of Grassland
Gansu Agricultural University, Lanzhou 730070, China

Abstract—A new species, *Anthracoidea macranthae* on *Kobresia macrantha* and a new record, *Anthracoidea foetidae* on *Carex duriuscula* subsp. *rigescens*, are reported.

Key words—smut fungi, Ustilaginomycetes, taxonomy

A species of *Anthracoidea* on *Kobresia macrantha* was collected from Xizang Autonomous Region in 2004. The host plant belongs to the section *Kobresia* of the genus *Kobresia*. So far 7 species of *Anthracoidea* on three sections of *Kobresia* have been recorded: 1) *Anthracoidea elynae* (Syd.) Kukkonen (1963: 65) with ustilospores measuring (14-)16-22(-25) μm in diam., wall 1-2.5(-3) μm , type on *Kobresia myosuroides* (Vill.) Fiori & Paol. (Sect. *Elyna*), 2) *A. kobresiae* (Mundk.) Kukkonen (1963: 44) with ustilospores measuring 14-21 x 10-18(-19) μm , wall 0.7-2.5 μm , type on *K. laxa* Boeck. (Sect. *Kobresia*), 3) *A. lindebergiae* (Kukkonen) Kukkonen (1963: 68) with ustilospores measuring (14-)15-20(-22.5) μm in diam., wall 0.7-2.5 μm , type on *K. simpliciuscula* (Wahlenb.) Mack. (Sect. *Kobresia*), 4) *A. filifoliae* L. Guo (1995-1996: 164) with ustilospores measuring (13-)16.5-22.5 x 12-19 μm , wall 1-2.5 μm , type on *K. filifolia* (Turcz.) C.B. Clarke (Sect. *Kobresia*), 5) *A. smithii* Kukkonen (1963: 74) with ustilospores measuring (17-)18-24 x 12-22 μm , wall 1-2 μm , type on *K. rupestris* H. Smith (Sect. *Hemicarex*), 6) *A. pygmaea* L. Guo (2002: 147) with ustilospores measuring 15.5-19.5(-22) x 15-19 μm , wall 1-2(-2.5) μm , type on *K. pygmaea* C.B. Clarke (Sect. *Hemicarex*) and 7) *A. yunnanensis* S.R. Wang & M. Piepenbr. (2002: 399) with ustilospores measuring (22-)24-28(-31) x (17-)18-23(-25) μm , wall 1-1.5(-2.5) μm , type on *K. esanbeckii* (Kunth) Wang & Tang ex P.C. Li (Sect. *Hemicarex*). The recently collected species of *Anthracoidea* in China is similar to *A. elynae* by ustilospores with a smooth surface as seen by scanning electron microscopy, but differs mainly by smaller ustilospores, thinner walls of the ustilospores and host plants in different sections of the genus *Kobresia*. A new species is described:

Anthracoidea macranthae* L. Guo & S.R. Wang, sp. nov.*Figs. 1-2**

Sori in ovariis, subglobosi, 2-2.5 mm diametro, primo membrana cinerascens, fungali cooperti, deinde expositi. Massa sporarum nigra, semiagglutinata. Ustilosporae a fronte subglobosae, late ellipsoideae vel leviter irregulares, 15-18(-19.5) x 13-17.5 µm, ab acie 10-13.5(-15) µm latae, hyalinae calyptrae vulgatae, rubrobrunneae vel flavidobrunneae; pariete aequaliter incrassato, ca. 0.5-1 µm crasso, tumores interni desunt, regiones lucem repercutientes desunt, superficie leve.

Sori in ovaries, subglobose, 2-2.5 mm in diam., at first covered by a grayish, fungal membrane, later becoming exposed. Spore mass black, semi-agglutinated. Ustilospores in plane view subglobose, broadly ellipsoidal or slightly irregular, 15-18(-19.5) x 13-17.5 µm, in side view 10-13.5(-15) µm wide, hyaline caps common on the flat side, reddish-brown or yellowish-brown; wall evenly thickened, ca. 0.5-1 µm, no internal swellings, no light reflective areas, surface smooth.

On *Kobresia macrantha* Boeck. (*Cyperaceae*, Gen. *Kobresia*, Sect. *Kobresia*), Xizang: Damxung, alt. ca. 4100 m, 9 VIII 2004, S. R. Wang, HMAS 130318 (holotypus hic designatus); Xizang: Maizhokunggar, alt. ca. 4500 m, 7 VIII 2004, S. R. Wang, HMAS 130317 (paratypus).

An *Anthracoidea* species on *Carex duriuscula* subsp. *rigescens* was collected in Gansu Province in 2003. There are 3 species of *Anthracoidea* on Subgen. *Vignea*, Sect. *Foetidae*: 1) *Anthracoidea foetidae*, 2) *A. kari* (Liro) Nannf. (1977: 368, Vánky 1994: 31) and 3) *A. variabilis* (S. Ito) Kakish. (1982: 29). The species from China is identified as *A. foetidae*, which is new to China (Guo 2000, 2002, 2004, Guo & Zhang 2004, Wang & Piepenbring 2002, Zhang & Guo 2004):

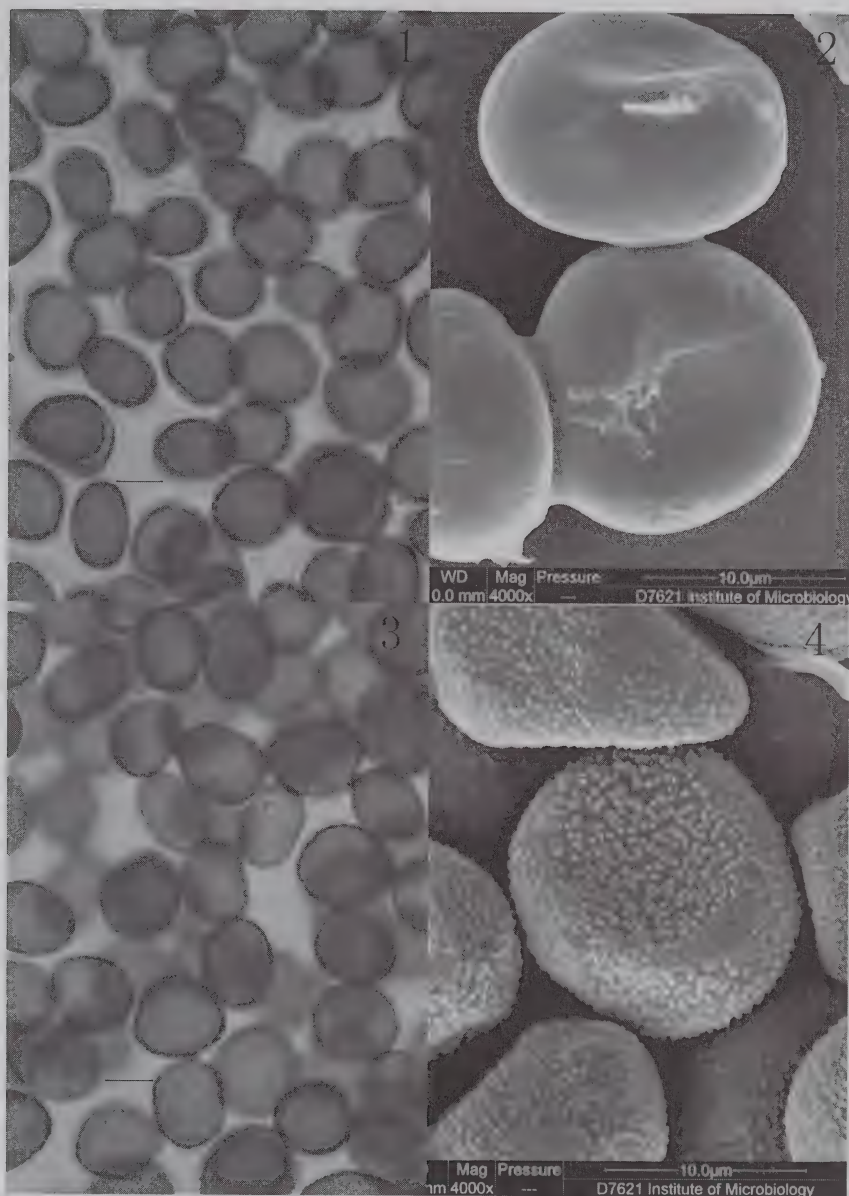
Anthracoidea foetidae* H. Zogg, Botanica Helvetica 93: 99, 1983.*Figs. 3-4**

Sori in ovaries, ovoid, 2-3 mm long and 1-1.5 mm wide, at first covered by a grayish, fungal membrane, later becoming exposed. Spore mass black, powdery. Ustilospores in plane view subglobose, ovoid, ellipsoidal or slightly irregular, (11-)12.5-20(-21.5) x (10-)11-17 µm, in side view 8.5-11 µm wide, reddish-brown or yellowish-brown; wall evenly thickened, ca. 0.5-1 µm, no internal swellings, no light reflective areas, surface densely verrucose, warts partly confluent.

On *Carex duriuscula* C. A. Mey subsp. *rigescens* (Franch.) S. Y. Liang et Y. C. Tang (*Cyperaceae*, Subgen. *Vignea*, Sect. *Foetidae*), Gansu: Yuzhong, Xinglongshan, alt. ca. 2750 m, 20 VII 2003, S. R. Wang, HMAS 130320.

Acknowledgements

The authors would like to express their deep thanks to Dr. Vánky and Prof. Piepenbring for reading the manuscript and serving as pre-submission reviewers, to Profs. Liang Songjun and Zhang Shuren (Institute of Botany, Chinese Academy of Sciences) for identifying the host plants, and to Mrs. Xie Jiayi for assistance with SEM photographs. This study was supported by the National Natural Science Foundation of China (No. 30230020 and No. 30270016) and Gansu Natural Foundation (No. ZR-97-041).



Figs. 1-2. Ustilosporium of *Anthracoidea macranthae* on *Kobresia macrantha* as seen by LM (light microscopy) and SEM (Scanning electron microscopy) (HMAS 130318, holotypus).

Figs. 3-4. Ustilosporium of *Anthracoidea foetidae* on *Carex duriuscula* subsp. *rigescens* as seen by LM and SEM (HMAS 130320).

Bars = 10 µm

Literature Cited

- Guo L. 1995-1996. *Anthracoidea filifoliae* sp. nov. and four smut species new to China. *Mycosystema* 8-9:163-168.
- Guo L. 2000. Flora Fungorum Sinicorum, *Ustilaginaceae* Vol. 12, Science Press, Beijing. 124 pp.
- Guo L. 2002. Two new species of Ustilaginomycetes and a species new to China. *Mycotaxon* 82:147-150.
- Guo L. 2004. *Anthracoidea shaanxiensis* sp. nov. (*Ustilaginales*) from China. *Nova Hedwigia* 79: 507-509.
- Guo L, Zhang HC. 2004. A new species and two new records of Ustilaginomycetes from China. *Mycotaxon* 90:387-390.
- Kakishima M. 1982. A taxonomic study on the *Ustilaginales* in Japan. *Mem. Inst. Agr. & For. Univ. Tsukuba* 1:1-124.
- Kukkonen I. 1963. Taxonomic studies on the genus *Anthracoidea* (*Ustilaginales*). *Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo"* 34(3): 1-122.
- Nannfeldt JA. 1977. The species of *Anthracoidea* (*Ustilaginales*) on *Carex* subgen. *Vignea* with special regard to the Nordic species. *Bot. Notiser* 130: 351-375.
- Vánky K. 1994. *European Smut Fungi*. Gustav Fischer Verlag Stuttgart, Jena, New York. 570 pp.
- Wang SR, Piepenbring M. 2002. New species and new records of smut fungi from China. *Mycol. Progress* 1: 399-408.
- Zhang HC, Guo L. 2004. Two new species and a new record of *Anthracoidea* (*Ustilaginales*) from China. *Mycotaxon* 89:307-310.

***Ascocoryne striata*, comb. nov.**

VIKTOR KUČERA & PAVEL LIZOŇ

viktor.kucera@savba.sk, pavel.lizon@savba.sk

Institute of Botany, Dept. of Cryptogams

Dúbravská 14, SK-845 23 Bratislava, Slovakia

Abstract—A new combination, *Ascocoryne striata*, is proposed. The species is re-described as well.

Keywords—*Bulgaria striata*, *Coryne striata*, *Leotiales*, USA, Austria

Introduction

Bulgaria striata was described by Ellis & Everhart (1885) and later it was treated in the genus *Coryne*. Because the holotype (NY) has apothecia with asci the taxon must be transferred to the genus *Ascocoryne* erected by Groves & Wilson (1967) to accommodate teleomorphs previously presented in *Coryne*.

Material and methods

All characters were observed in dry specimens. Structures of microscopic characters were studied using a light microscope (oil immersion): fragments of ascocarps were examined in Melzer's Reagent and in a solution of Congo Red (1 ml of 25% ammonia dissolved in a filtered solution of 1.5 g of Congo Red and 50 ml of distilled water). Values of micromorphological characters are shown as average $\pm$ standard deviation of 30 measurements (marginal values in parentheses). Herbarium acronyms follow Index Herbariorum (Holmgren & al., 1990).

Taxonomy

***Ascocoryne striata* (Ellis & Everh.) V. Kučera & Lizoň, comb. nov.**

Fig. 1

≡ *Bulgaria striata* Ellis & Everh., J. Mycol. 1: 90, 1885, basionym.

≡ *Coryne striata* (Ellis & Everh.) Sacc., Syll. fung. 8: 643, 1889.

≡ *Didymocoryne striata* (Ellis & Everh.) Sacc. & Trotter, Syll. Fung. 22: 730, 1913.

Apothecia solitary or in small clusters, 2–4 mm broad and 1 mm high, cup-shaped to flattened, sessile, irregularly obconical, gelatinous, distinctly striate when dry.

Thecium circular, concave, margin obtuse, purplish-brown with violaceous tint.

Medullary excipulum of textura intricata, up to 650 μ m thick, cells 18–45 $\times$ 2.5–5 μ m, hyaline, immersed in a gelatinous matrix. **Ectal excipulum** up to 120 μ m thick,

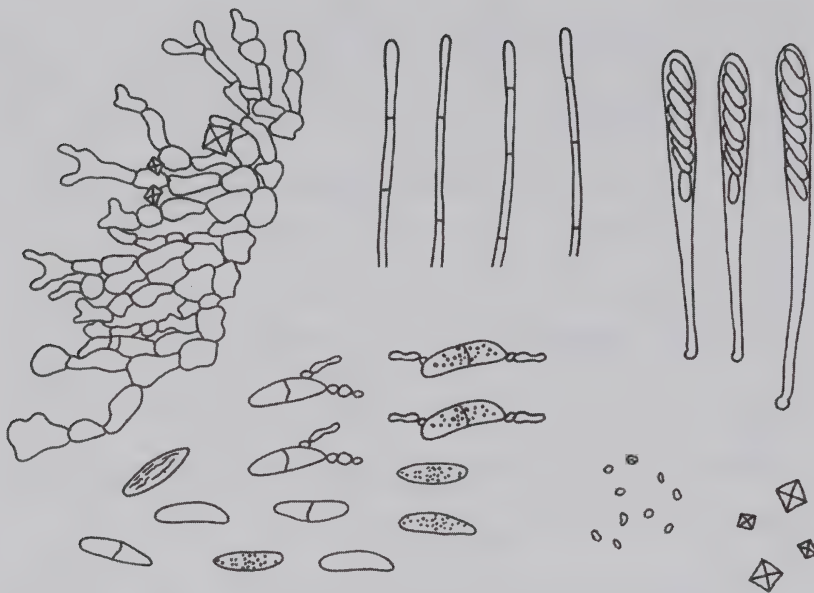


Fig. 1. Teleomorph of *Ascocoryne striata* comb. nov.: ectal excipulum, paraphyses, asci, spores, blastoconidia, oxalate crystals (bar = 10 μm for all, 15 μm for asci)

of irregularly branched cells and hyphae, individual cells ampuliform, fusiform, irregularly curved, somewhat sigmoid, horn-shaped, often slightly swollen 8–12 $\times$ 4–8 μm ; containing oxalate crystals. **Asci** biserial, 8-spored, 85–150 $\times$ 7–10 μm , clavate, slender towards the base, apical pore blueing in Melzer's Reagent. **Spores** (10–) 12–14 (–20) $\times$ 3–3.5 (–6) μm , narrowly elliptical to fusiform, straight or slightly curved, hyaline, usually 1-septate, with numerous lipid bodies 0.5–1 μm diam., budding ovoid to irregular blastoconidia, 1.5–2 μm . **Paraphyses** narrow, slender or only slightly swollen at the tip, unbranched, terminal cell 12–15 $\times$ 1–2 μm . **Anamorph** unknown.

Specimens examined – **Austria**: Tirol, J. Lütkemüller (W 6596, as *Coryne sarcoides*). **U. S. A.**: Oregon, on decayed wood, Nov. 1884, W. S. Carpenter 106 (NY 7250, holotype of *Bulgaria striata*).

Discussion

Ascocoryne striata is a rare, little known fungus characterised by the receptacle's striate margin, the occurrence of ampuliform, sigmoid or irregular cells and the presence of oxalate crystals in the ectal excipulum. *A. cylichnium* has also oxalate crystals but excipular cells are $\pm$ regular.

The name *Bulgaria striata*, since its publication by Ellis & Everhart (1885), has been scarcely used both in the literature and in herbarium specimens. Only two specimens,

one from the U.S.A. (NY 7250) and another from Austria (W 6596), have been located although all major world herbaria were searched. Two specimens in CUP (063597, 065323) stored under the name *Ascocoryne striata* (Ellis & Everh.) Korf^c represent different taxa of *Ascocoryne*.

Wilson (1962) pointed out that anamorphs are often mixed with teleomorphs and that phialides tend to be in compact verticils with narrow, straight and upright, symmetrical branches. We have, as noted above, located and studied only two specimens in NY and W that represent *Ascocoryne striata* and neither of them has either sporodochia or conidiophores. We were not able to study any of the specimens seen by Wilson in DAOM and/or TRTC.

Acknowledgements

Drs. Richard P. Korf (Cornell University, Ithaca, USA), Teresa M. Iturriaga (Universidad Simón Bolívar, Caracas, Venezuela) and Wen-Ying Zhuang (Institute of Microbiology, Chinese Academy of Sciences, Beijing, China) kindly reviewed and commented this paper. Monographic study on of the genus *Ascocoryne* is the theme of the PhD dissertation of the senior author and was supported by the grant agency APVT (51-023902).

Literature cited

- Ellis JB & Everhart BM. 1885. New species of fungi. *J. Mycol.* 1: 88–93.
- Groves JW & Wilson DE. 1967. The nomenclatural status of *Coryne*. *Taxon* 16: 35–41.
- Holmgren PK, Holmgren NH & Barnett LC (eds.). 1990. *Index Herbariorum 1: The herbaria of the world*. The New York Botanical Garden Press, Bronx, New York, 693 p.
- Wilson DE. 1962. A study of eight North American species of *Coryne*. Ms., PhD thesis, University of Toronto. 39 p. + 11 pl.

***Inocutis subdryophila* (Basidiomycota), a new polypore from China**

YU-CHENG DAI

yuchengd@yahoo.com

Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

HAI-SHENG YUAN

Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China
Graduate School, Chinese Academy of Sciences
Beijing 100039, China

Abstract — A new polypore, *Inocutis subdryophila* collected from Xizang Autonomous Region, southwestern China, is described and illustrated. The new species has ungulate basidiocarps with azonate upper surface; its core and tubes are corky when dry; hyphae of mycelial flecks in its core are very thick (up to 12 μm in diam), and contextual hyphae of the basidiocarp are thin-walled throughout; it was found on gymnosperm tree (most probably *Abies*). *Inocutis subdryophila* resembles *I. dryophila* in macroscopy, but differs by having smaller basidiospores ($5.7\text{--}6.6 \times 4.0\text{--}4.8 \mu\text{m}$ vs. $7.2\text{--}8.2 \times 5.4\text{--}6.1 \mu\text{m}$). The basidiospores of *I. subdryophila* are very similar to those of *Inocutis rheades*, but the latter has mostly applanate basidiocarps, and its upper surface is distinctly zonate and tomentose. *I. rheades* has a hard core, and its tubes are brittle when dry. In addition, hyphae of the mycelial flecks in its core are thin ($2\text{--}3.5 \mu\text{m}$ in diam), and its contextual hyphae vary from thin-walled to distinctly thick-walled.

Key words — Basidiomycota, *Hymenochaetaceae*, taxonomy

Introduction

Inocutis Fiasson & Niemelä was established by Fiasson & Niemelä (1984). Species of the genus were usually included in *Inonotus* P. Karst. sensu lato (Pegler 1964, Gilbertson & Ryvarden 1986, Ryvarden 1991, Ryvarden & Gilbertson 1993). The main characteristics of *Inocutis* are the presence of a granular core and the lack of setae, and the species make a monophyletic genus within the *Hymenochaetaceae* (Fiasson & Niemelä 1984, Wagner & Fischer 2001).

During a study on poroid *Aphyllorphorales* in China, three specimens collected from the Xizang Autonomous Region, southwestern China, were carefully studied. They have ungulate basidiocarps with a distinct granular core, monomitotic hyphal structure

with simple septa, and they have no setae. Morphological characters suggested these collections to belong to *Inocutis*, and to represent an undescribed species. The illustrated description is made in this study.

The studied materials are mostly deposited at the Herbarium of the Institute of Applied Ecology, Chinese Academy of Sciences (IFP); for comparison, a few specimens from other herbaria (mentioned in the text) were studied to compare our results. The microscopic routine used in the study is as presented by Dai (1999). The following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width), n = number of spores measured from given number of specimens. In presenting the variation in the size of spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses; IKI stands for Melzer's reagent and KOH for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and IKI- means both inamyloid and indextrinoid.

Description

Inocutis subdryophila Y.C. Dai & H.S. Yuan, **sp. nov.**

Fig.1

Carpophorum annuum, *solitarium*, *ungulatum*, *pallido cinerascens vel brunneum*; *pori* 2–4 per mm. *Systema hypharum monomiticum*, *hyphae septatae*, *hyphae contexti* 3–6 μm in diametro. *Sporae perlate ellipsoideae*, *crassitunicatae*, *aureae*, IKI–, CB(+), 5.7–6.6 $\times$ 4.0–4.8 μm .

Holotype here designated. — **China**. Xizang Autonomous Region, Bomi County, Gawalong, Nanyigou, alt. 3500 m, on gymnosperm tree, 17.VII.2004 Li 283 (holotype in IFP, isotype in HMAS).

Etymology. — *Subdryophila*, somewhat resembling *Inocutis dryophila*.

Basidiocarps. — Annual, solitary, pileate, sessile. Pileus unguulate, projecting up to 5 cm long, 6 cm wide, and 4 cm thick. Pileal surface pale grayish brown to yellowish brown, finely velutinate to glabrous, azonate, margin sharp, curved down when dry. Pore surface pale grayish brown to pale yellowish brown; pores angular, 2–4 per mm, dissepiments thin, slightly lacerate. Context yellowish brown, fibrous to corky, zonate, up to 3 cm thick; granular core present, occupying most of the context, yellowish brown with white mycelial flecks, up to 3 cm in diam. Tubes brown, slightly darker than context, distinctly darker than pore surface, corky, up to 2 cm long.

Hyphal structure. — Hyphal system monomitic; all septa without clamp connections; tissues darkening but otherwise unchanged in KOH.

Context. — Generative hyphae pale yellowish to golden brown, thin to slightly thick-walled with a distinct lumen, occasionally branched, frequently simple septate, with a radial orientation, 3–6 μm in diam. Branched sclerids present in granular core, dark brown, distinctly thick-walled with a medium or narrow lumen, flexuous, up to 8 μm in diam. Hyphae of mycelial flecks hyaline, thin- to slightly thick-walled, occasionally branched, with constricted simple septa, mostly 5–8 μm in diam, some up to 12 μm in diam.

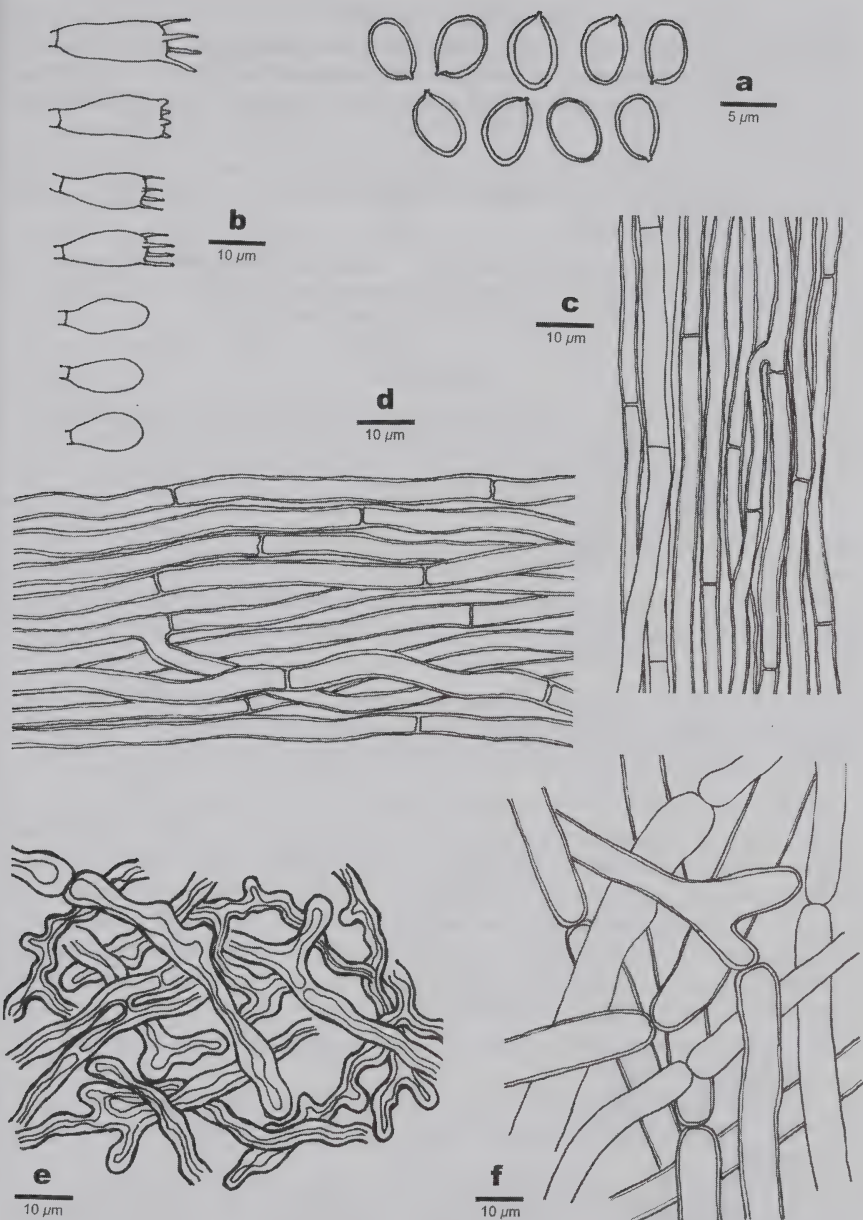


Fig. 1. Microscopical structures of *Inocutis subdryophila* (drawn from holotype).
 —a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from trama. —d: Hyphae from
 context. —e: Sclerids from granular core. —f: Hyphae from mycelial flecks.

Tubes. — Tramal hyphae yellowish, thin- to slightly thick-walled with a wide lumen, occasionally branched, with frequent simple septa, parallel along the tubes, 2.5–4.5 μm in diam. Setae and other sterile elements absent; basidia clavate, with four sterigmata and a simple basal septum, 13–20 $\times$ 5–7 μm ; basidioles in shape similar to basidia, but smaller.

Spores. — Basidiospores ellipsoid, yellowish brown, thick-walled, smooth, IKI–, CB + when juvenile, (5.6–)5.7–6.6(–6.8) $\times$ (3.9–)4.0–4.8(–4.9) μm , L = 6.08 μm , W = 4.28 μm , Q = 1.38–1.47 (n = 90/3).

Additional specimens (paratypes) examined. — **China**. Xizang Autonomous Region, Bomi County, Songzongji, alt. 3200 m, on gymnosperm tree, 16.VII.2004 Li 278; Milin County, Nanyigou, on gymnosperm tree, 21.VII.2004 Li 460.

Discussion

Species of *Inocutis* occur in temperate and boreal forests of northern hemisphere, and six species have been included in the genus so far (Dai et al. 1997, Fiasson & Niemelä 1984, Gilbertson & Ryvarden 1986, Gottlieb et al. 2002, Ryvarden & Gilbertson 1993, Wagner & Fischer 2002): *I. dryophila* (Berk.) Fiasson & Niemelä, *Inocutis jamaicensis* (Murrill) A.M. Gottlieb, J.E. Wright & Moncalvo, *I. levis* (P. Karst.) Y.C. Dai, *Inocutis ludoviciana* (Pat.) T. Wagner & M. Fisch., *I. rheades* (Pers.) Fiasson & Niemelä and *I. tamaricis* (Pat.) Fiasson & Niemelä. Among them, *I. jamaicensis* and *I. ludoviciana* are lack of granular core. *I. rheades* has smaller basidiospores (less than 6.6 μm long) than the other three (more than 6.6 μm long).

Macroscopically, *Inocutis subdryophila* resembles *I. dryophila* which has, however, bigger basidiospores (7.2–8.2 $\times$ 5.4–6.1 μm), and gloeoplerous hyphae are present in its trama. In addition, *I. dryophila* grows almost invariably on *Quercus*.

Inocutis subdryophila has very similar basidiospores as *I. rheades*. However, the basidiocarps of *I. rheades* are more flat, applanate than in the new species, and its upper surface is distinctly zonate, tomentose or even hairy, while *I. subdryophila* is fairly uniform and only velutinate on its pileal surface. Further differences were found in the section of *I. rheades*: core is very hard and tubes are brittle (both these are corky in *I. subdryophila*). The consistently thin-walled hyphae of the new species contrast with the variably thin- to thick-walled hyphae of *I. rheades*, those pale-coloured mycelial flecks consist of very narrow (2–3.5 μm in diam) hyphae only.

Other specimens examined. — *Inocutis dryophila*. **Sweden**, Västmanland, on *Quercus*, 15.VII.1976 Nordin (H).

— *I. levis*. **China**, Ningxia Auto. Reg., Helan Mts., on living *Ulmus*, 28.VIII.2003 Dai 4903. Xinjiang Autonomous Region, on angiosperm tree, 15.IX.1958 Xu 343 (HMAS 25958).

— *I. rheades*. **China**, Beijing, Baihuashan, on fallen trunk of *Populus*, 2.XI.1993 Dai 1840. Heilongjiang Prov., Huzhong County, Xiushan Forest Farm, on fallen trunk of *Populus*, 17.VIII.2003 Dai 4673 (IFP). **Finland**, Etelä-Häme, Lammi, on fallen trunk of *Populus*, 17.IX.1996 Dai 2290 & Niemelä (H).

— *I. tamaricis*. **China**, Beijing, Botanical Garden of the Chinese Academy of Forestry, on living *Tamarix*, 5.VII.1993 Dai 318 (IFP).

Acknowledgements

We express our gratitude to Prof. Teuvo Ahti (University of Helsinki, Finland) for helping with the preparation of the Latin descriptions, and to Drs. Tuomo Niemelä (University of Helsinki, Finland) and Manfred Binder (Clark University, USA) for reviewing the manuscript. The study is supported by the National Natural Science Foundation of China (Project No. 30425042).

Literature cited

- Dai YC. 1999: *Phellinus* sensu lato (*Aphylliphorales*, *Hymenochaetaceae*) in East Asia. — Acta Bot. Fennica 166: 1–115.
- Dai YC, Niemelä T, Zang M. 1997: Synopsis of the genus *Inonotus* (Basidiomycetes) sensu lato in China. — Mycotaxon 65: 273–283.
- Fiasson JL, Niemelä T. 1984: The *Hymenochaetales*: a revision of the European poroid taxa. — Karstenia 24: 14–28.
- Gilbertson RL, Ryvarden L. 1986: North American polypores 1. — Fungiflora, Oslo. 436 pp.
- Gottlier A, Wright JE, Noncalvo JM. 2002: *Inonotus* s.l. in Argentina — morphology, cultural characters and molecular analyses. — Mycol. Progr. 1: 299–313.
- Pegler DN. 1964: A survey of the genus *Inonotus* (*Polyporaceae*). — Trans. British Mycol. Soc. 47: 175–195.
- Ryvarden L. 1991: Genera of polypores. Nomenclature and taxonomy. — Synopsis Fungorum 5: 1–363.
- Ryvarden L, Gilbertson RL. 1993: European polypores 1. — Synopsis Fungorum 6: 1–387.
- Wagner T, Fischer M. 2001: Natural groups and a revised system for the European poroid *Hymenochaetales* (Basidiomycota) supported by nSLU rDNA sequence data. — Mycol. Res. 105: 773–782.
- Wagner T, Fischer M. 2002: Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetic relationships of allied genera. — Mycologia 94: 998–1016.

Two new species of *Steccherinum* (Basidiomycota) from China

HAI-SHENG YUAN

Yuanhs911@yahoo.com

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

*Graduate School, Chinese Academy of Sciences
Beijing 100039, China*

YU-CHENG DAI

yuchengd@yahoo.com

*Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China*

*Systematic Mycology & Lichenology Laboratory, Chinese Academy of Sciences
Beijing 100080, China*

Abstract — *Steccherinum subglobosum* and *S. subulatum* are described as new species, and illustrations and descriptions of the two species are supplied. *S. subglobosum* is characterized by effused-reflexed basidiocarps with duplex context, both leptocystidia and skeletocystidia, hyphal pegs, and subglobose basidiospores. The characteristics of *S. subulatum* are resupinate to effused-reflexed basidiocarps, grayish pink spines, subulate skeletocystidia, and broadly ellipsoid basidiospores.

Key words — lignicolous corticioid fungi, *Polyporales*, taxonomy

Introduction

The genus *Steccherinum* Gray is characterized by its odontoid hymenophore, a dimitic hyphal structure with cyanophilous skeletal hyphae, skeletocystidia that are strongly encrusted at apex, and relatively uniform and small, thin-walled basidiospores (Eriksson et al. 1984). It is very closely related to *Junghuhnia* Corda emend. Ryvarden, but the latter genus has a poroid hymenophore (Niemelä 1998). Until now around 40 species have been found in the genus. Eleven species of *Steccherinum* have previously been recorded from China (Kotiranta & Mukhin 1998, Dai et al. 2004, Yuan & Dai 2005), which is certainly an underestimate of the diversity of *Steccherinum* in China including huge boreal, temperate, and subtropical areas.

During a survey on the diversity of lignicolous fungi in China, which is supported by the National Natural Science Foundation of China, collections of two undescribed

Steccherinum species were made. The materials studied are described as new taxa in this study and are compared to other species in *Steccherinum*.

Materials and methods

The studied specimens are deposited at Herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP). Microscopy was studied, and measurements and drawings were made from slide preparations stained with Cotton Blue (CB) and Melzer's reagent (IKI). CB+ means cyanophilous and CB- acyanophilous, and IKI- means both inamyloid and indextrinoid. In presenting the variation in the size of the spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses. In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = quotient of the mean spore length and the mean spore width (L/W ratio), n = number of spores measured from given number of specimens. Colour terms mostly follow Rayner (1970) and Petersen (1996).

Taxonomy

Steccherinum subglobosum H.S. Yuan & Y.C. Dai, **sp. nov.**

Fig. 1

Carpophorum annuum, effuso-reflexum vel pileatum, hydnaceum; dentes usque ad 2 mm longi, 3–5 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales contexti 2–5 μm in diam. Skeletocystidia abundantes, clavata, incrustata. Sporae hyalinae, subglobosae, 3.9–4.6 $\times$ 3.3–3.9 μm .

Holotype here designated. — **China.** Hubei Prov., Shennongjia Nature Reserve, on fallen angiosperm branch, 25.IX.2004 Dai 5589 (IFP).

Etymology. — *Subglobosus*: subglobose, referring to the shape of basidiospores.

Fruitbody. — Basidiocarps annual, effused-reflexed or pileate, solitary to imbricate, or confluent and forming fairly large patches; effused part up to 10 cm long and 3 cm wide; pileus projecting up to 1 cm long, 2 cm wide, and 1 mm thick. Piler surface velutinate to tomentose, concentrically grooved, mostly zonate, grayish buff to light vinaceous gray, darker in the grooves; margin acute, usually curved down when dry. Hymenophore odontoid, smooth to subtomentose between aculei, cream to buff. Spines crowded, orange to yellowish brown, becoming darker with age, subulate, terete, simple or confluent, up to 2 mm long, 3–5 per mm. Context duplex, lower layer white to cream, leathery, up to 0.6 mm thick; upper layer gray to dark gray, soft corky, up to 0.4 mm thick.

Hyphal structure. — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae thick-walled to subsolid, IKI-, CB+; tissues unchanged in KOH.

Context. — Generative hyphae hyaline, thin-walled, bearing clamp connections, moderately branched, 2.5–4 μm in diam.; skeletal hyphae thick-walled to subsolid, rarely branched, 2–5 μm in diam.; hyphae loosely interwoven in upper layer and tightly interwoven in lower layer.

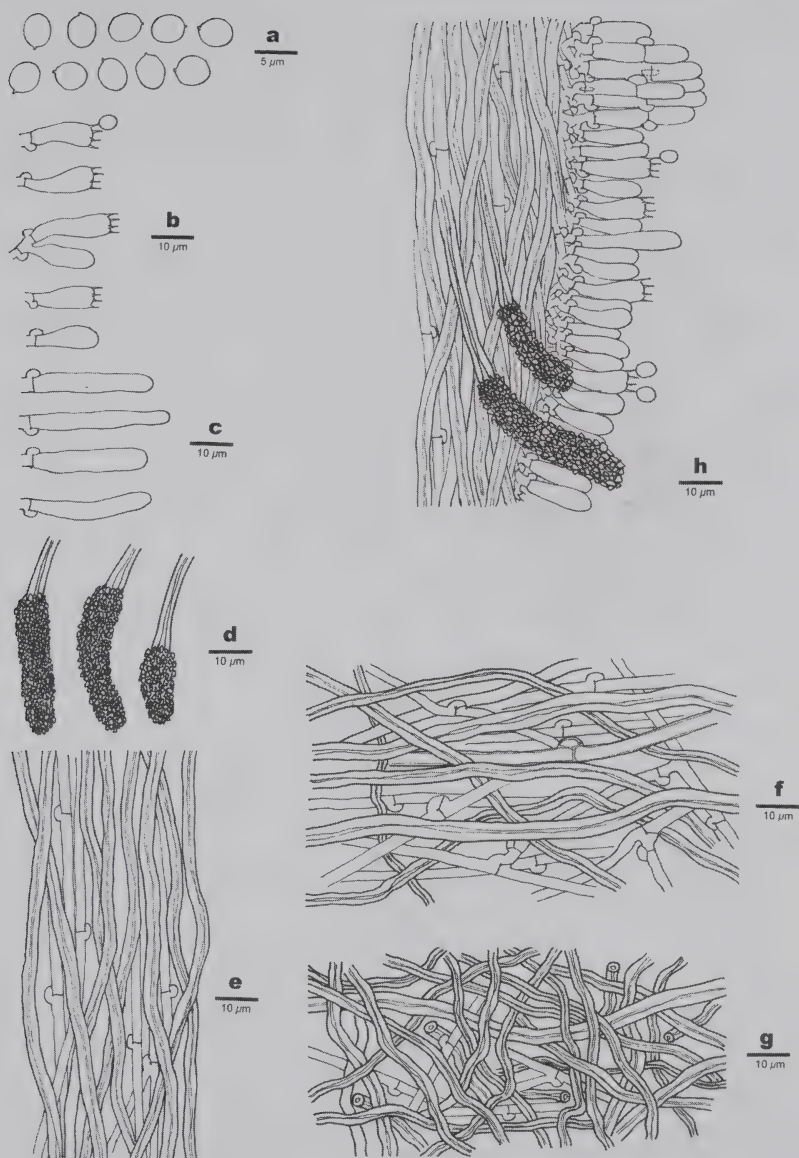


Fig. 1. Microscopical structures of *Steccherinum subglobosum* (holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Leptocystidia. —d: Encrusted skeletocystidia. —e: Hyphae from trama. —f: Hyphae from upper layer of context. —g: Hyphae from lower layer of context. —h: A section of trama.

Spines. — Tramal hyphae dominated by skeletal hyphae; generative hyphae hyaline, thin-walled, bearing clamp connections, occasionally branched, 1.8–3 μm in diam.; skeletal hyphae thick-walled to subsolid, unbranched, parallel or subparallel along the spines, 2–3.5 μm in diam. Hyphal pegs occasionally present; skeletocystidia abundant, clavate, thick-walled, originated from trama, imbedded or protruding, heavily encrusted, 15–60 $\times$ 6–9 μm (encrusted part included); apex obtuse; leptocystidia thin-walled, clavate to cylindrical, originated from subhymenium, 25–32 $\times$ 3.5–6 μm ; basidia clavate, with a basal clamp connection and four sterigmata, 12–17 $\times$ 5–6 μm .

Spores. — Basidiospores subglobose, hyaline, thin-walled, smooth, IKI–, CB–, 3.9–4.6(–4.7) $\times$ 3.3–3.9(–4) μm , L= 4.17 μm , W= 3.62 μm , Q= 1.14–1.17 (n=90/3).

Additional specimens examined. — **China.** Xizang Autonomous Region, Linzhi County, Ecological Station, alt. 3,700 m, on fallen trunk of *Betula*, 31.VII.2004 Dai 5437; Bayi, 3,100 m on fallen angiosperm branch, 1.VIII.2004 Dai 5532; 3.VIII.2004 Dai 5633.

Remarks. — *Steccherinum subglobosum* is characterized by effused-reflexed basidiocarps with duplex context, both leptocystidia and skeletocystidia, hyphal pegs, and subglobose basidiospores. Macroscopically, it is easily confused with *S. ochraceum* (Pers.:Fr.) Gray and *S. hydneum* (Rick) Maas Geest. The three species share similar characters in flesh color, evenly distributed spines and leathery texture of context (Maas Geesteranus 1974). However, *S. subglobosum* differs from *S. ochraceum* mainly in the shape and size of basidiospores: they are subglobose, 3.9–4.6 $\times$ 3.3–3.9 μm in the former; while they are ellipsoid, 3.1–3.4 $\times$ 2.0–2.3 μm in the latter. *Steccherinum subglobosum* distinguishes from *S. hydneum* by its duplex context, smaller basidiospores without guttule, and by having hyphal pegs. In contrast, *S. hydneum* has homogeneous context, bigger basidiospores (4.2–5 $\times$ 3.6–4.1 μm) with a guttule, and it lacks hyphal pegs.

***Steccherinum subulatum* H.S. Yuan & Y.C. Dai, sp. nov.**

Fig.2

Carpophorum annuum, resupinatum vel effuso-reflexum, hydneaceum; dentes usque ad 1 mm longi, 3–6 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales contexti 2–5 μm in diam. Skeletocystidia abundantes, subulata, incrustata. Sporae hyalinae, perlate ellipsoideae, 3.8–5 $\times$ 2.3–3 μm .

Holotype here designated. — **China.** Hubei Prov., Shennongjia Nature Reserve, on fallen branch of *Celtis*, 25.IX.2004 Dai 5907 (IFP).

Etymology. — *Subulatus*: subulate, referring to the shape of skeletocystidia.

Fruitbody. — Basidiocarps annual, resupinate to effused-reflexed. Resupinate part up to 4 cm long and 2 cm wide, tightly adnate, margin thinning out, white to grayish buff, radially fimbriate; pileus projecting up to 3 mm long, 1 cm wide, and 0.5 mm thick. Pileal surface grayish buff to clay pink, glabrous, azonate, margin acute, curved down when dry. Hymenophore hydroid when mature, smooth to subtomentose between aculei, cream to pinkish cream. Spines sparse when juvenile, crowded with age, pinkish buff to grayish pink, subulate, terete, simple or confluent, rigid when dry, up to 1 mm long, 1–3 per mm when young, 3–6 per mm when old. Context very thin, cream, leathery when dry.

Hyphal structure. — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae thick-walled to subsolid, IKI–, CB+; tissues unchanged in KOH.

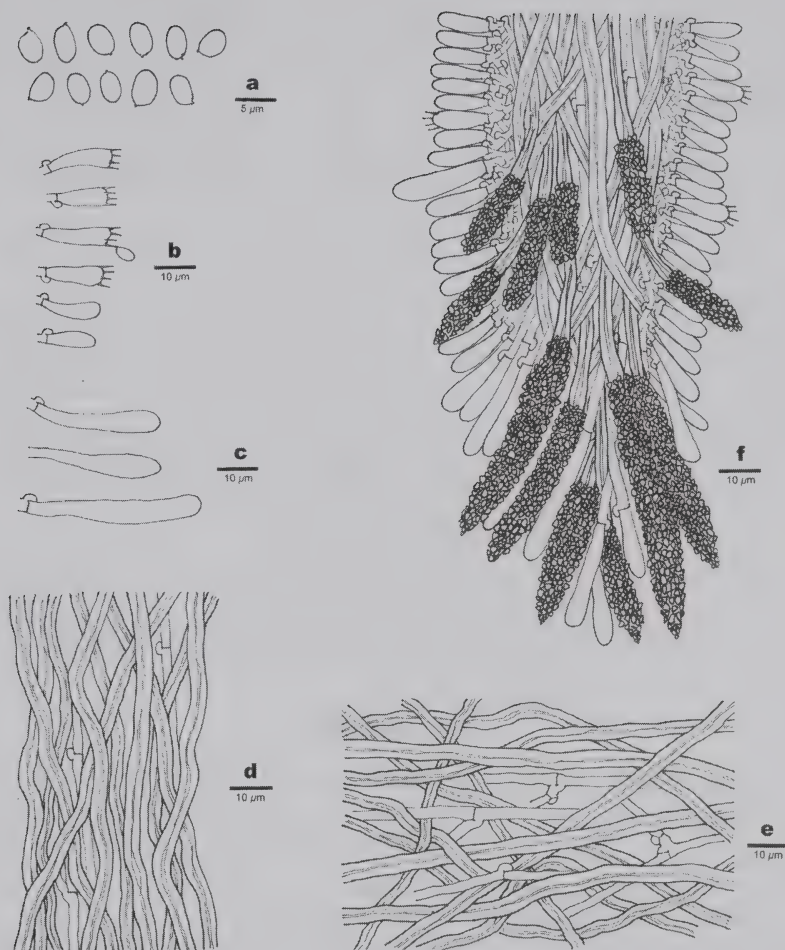


Fig. 2. Microscopical structures of *Steccherinum subulatum* (holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Leptocystidia. —d: Hyphae from trama. —e: Hyphae from subiculum. —f: A section of trama.

Context. — Generative hyphae hyaline, thin-walled, bearing clamp connections, occasionally branched, 2–3 μm in diam.; skeletal hyphae thick-walled to subsolid, rarely branched, 2–5 μm in diam., loosely interwoven.

Spines. — Tramal hyphae similar to contextual hyphae, generative hyphae hyaline, thin-walled, bearing clamp connections, occasionally branched, 2–3.5 μm in diam.; skeletal hyphae thick-walled to subsolid, very rarely branched, subparallel along the

spines, 2.5–6 μm in diam. Skeletocystidia abundant, mostly subulate, thick-walled, originated from trama, heavily encrusted, 22–45 $\times$ 6–10 μm (encrusted part included), apex mostly acute; leptocystidia thin-walled, clavate, originated from subhymenium, mostly present on tip of spines, 30–42 $\times$ 5–6 μm ; basidia clavate, with a basal clamp connection and four sterigmata, 13–18 $\times$ 4–5 μm .

Spores. — Basidiospores broadly ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, (3.7–)3.8–5(–5.1) $\times$ (2–)2.3–3 μm , $L = 4.12 \mu\text{m}$, $W = 2.75 \mu\text{m}$, $Q = 1.46\text{--}1.52$ ($n = 78/3$).

Additional specimen examined. — **China**. Zhejiang Prov., Lin'an County, Tianmushan Nature Reserve, on fallen branch of angiosperm, 15.X.2004 Dai 6396.

Remarks. — The characteristics of *Steccherinum subulatum* are resupinate to effused-reflexed basidiocarps, grayish pink spines, subulate skeletocystidia, and broadly ellipsoid basidiospores. *S. subulatum* has similar skeletocystidia and basidiospores as in *S. aggregatum* Hjortstam & Spooner and *S. laeticolor* (Berk. & M.A. Curtis) Banker (Hjortstam *et al.* 1990). However, *S. aggregatum* has a monomitic hyphal structure in its context, and colour of its basidiocarps is dingy fawn. *S. laeticolor* has reddish to brick red basidiocarps, and its generative hyphae usually bear crystals (Banker 1912).

Acknowledgements

We thank Ms. Yu-Lian Wei, Chang-Jun Yu, Juan Li, Mr. Ming-Yun Huang and Han-Cheng Wang (Shenyang, China) for companion on field trips. We express our gratitude to Drs. Sheng-Hua Wu (National Museum of Natural Science, Taiwan) and Manfred Binder (Clark University, USA) for reviewing the manuscript. The research was supported by National Natural Science Foundation of China (Project No. 30425042).

Literature cited

- Banker HJ. 1912: Type studies in the *Hydnaceae* 2. The genus *Steccherinum*. *Mycologia* 4: 309–318.
- Dai YC, Wei YL, Zhang XQ. 2004: An annotated checklist of non-poroid Aphyllophorales in China. *Ann. Bot. Fennici* 41: 233–247.
- Eriksson J, Hjortstam K, Ryvarden L. 1984: The Corticiaceae of North Europe 7. *Schizopora* – *Suillosporium*. *Fungiflora*, Oslo. 1–169 pp.
- Hjortstam K, Spooner BM, Oldridge SG. 1990: Some Aphyllophorales and Heterobasidiomycetes from Sabah, Malaysia. *Kew Bulletin* 45: 303–321.
- Kotiranta H, Mukhin VA. 1998: Polyporaceae and Corticiaceae of an isolated forest of *Abies nephrolepis* in Kamchatka, Russian Far East. *Karstenia* 28: 69–80.
- Maas Geesteranus RA. 1974: Studies in the genera *Irpex* and *Steccherinum*. *Persoonia* 7: 443–581.
- Niemelä T. 1998: *Steccherinum bourdotii* in North Europe. *Folia Crypt. Estonica* 33: 93–97.
- Petersen JH. 1996: Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve. 6 unnumbered pp.
- Rayner RW. 1970: A mycological colour chart. Commonwealth Mycol. Inst., Kew. 34 pp., 9 plates.
- Yuan HS, Dai YC. 2005: Two species of *Steccherinum* (Basidiomycota, Aphyllophorales) new to China. *Fung. Sci.* 20: 35–39.

New records and a new species of *Canalisporium* from aquatic habitats in Panama

ASTRID FERRER & CAROL A. SHEARER

aferrer@life.uiuc.edu

Department of Plant Biology, University of Illinois
265 Morrill Hall, 505 S. Goodwin Avenue, Urbana, Illinois 61801

Abstract—*Canalisporium panamense*, a new species of aquatic mitosporic fungus from wood submerged in freshwater habitats in Panama, is described and illustrated. The characteristic features of the new species are colonies with few conidia, conidiogenous cells integrated, and dematiaceous muriform conidia. The conidia of *C. panamense* are larger in size ($50\text{--}70 \times 46\text{--}60 \mu\text{m}$) and have more septa than other described species in the genus. *Canalisporium caribense*, *C. elegans*, *C. kenyense*, and *C. pulchrum* are reported for the first time from wood submerged in rivers in lowland forests of Panama. No *Canalisporium* species were found at high elevations.

Key words—mitosporic fungi, freshwater fungi, taxonomy

Introduction

This study is part of an extensive survey of species of freshwater fungi in the tropical rain forests of Panama. We report collections of five species in the genus *Canalisporium* Nawawi & Kuthub. from three different forest sites.

Canalisporium is a pantropical genus with 8 recognized species (Nawawi & Kuthubutheen 1989, Goh et al 1998, Sivichai 1999, Goh & Hyde 2000, Cai et al 2003). Few reports have been made from the neotropics, and include records from Cuba (Holubová-Jechová and Mercado Sierra 1984). The conidia of *Canalisporium* species are olivaceous brown, reddish brown to dark brown, muriform, smooth, broadly ellipsoidal, obpyriform to subglobose and complanate. Most species have a single basal cell that is cuneiform, thin-walled, and subhyaline to light brown. The arrangement of septa in the conidia to produce regularly arranged cells in rows and columns, and the presence of septal canals is distinctive for *Canalisporium* (Nawawi & Kuthubutheen 1989, Goh et al 1998, Cai et al 2003, Ho & Hyde 2004).

During our characterization of *Canalisporium* species from Panama, we identified a new species with morphological characteristics similar to those of other species of *Canalisporium*, but differing in conidial size and number of septa. In addition, we found *C. caribense*, *C. elegans*, *C. kenyense*, and *C. pulchrum*. Since most of these species are first records for Panama, and/or the Western hemisphere, descriptions of each species

and information on their distribution are included. These new reports suggest that some species of the genus *Canalisporium* are more widespread and common than previously recognized.

Materials and methods

Thirty samples of submerged partially decomposed woody debris were collected from rivers and streams at the Soberania National Park, and at the Barro Colorado Nature Monument (BCNM), which support lowland tropical forest in Central Panama, and from submerged dead leaves of *Typha domingensis* Pers. in Gatun Lake surrounding BCNM. In addition, samples were collected from submerged partially decomposed woody debris in streams at the Fortuna Reserve, a montane tropical forest at 1000m elevation in Western Panama.

Samples were incubated in the laboratory in plastic boxes containing moistened paper towels at ambient temperature (about 24° C) and were examined with a dissecting microscope immediately after collection and periodically over 9 months.

Fungi were removed from the substrate and placed in a drop of distilled water on a glass slide. Measurements and photographs of the conidiophores, conidiogenous cells, and conidia were made of material mounted in distilled water.

Cultures were obtained from single spores plated on antibiotic water agar (0.5 mg streptomycin sulfate, 0.5 mg penicillin G, 18 g agar, 1L distilled water). Single germinated spores were located using the dissecting microscope and transferred to and grown on potato-dextrose-agar (PDA, Difco) at 24 C. Sporulation was stimulated by adding small autoclaved strips of banana leaves to PDA (Nawawi & Kuthubutheen 1989). Digital images were obtained with a Spot RT digital camera using an Olympus microscope equipped with Nomarski interference and phase optics. Specimens are deposited in the Herbarium of the University of Illinois at Urbana Champaign (ILL) and in the Herbarium of the University of Panama (PMA).

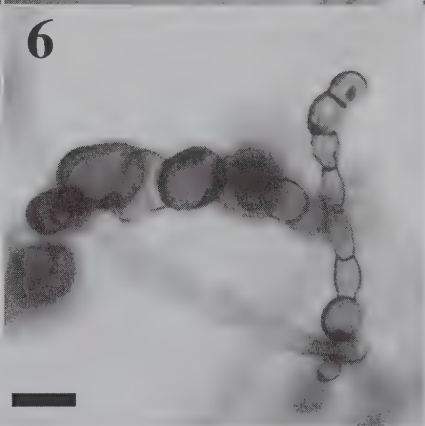
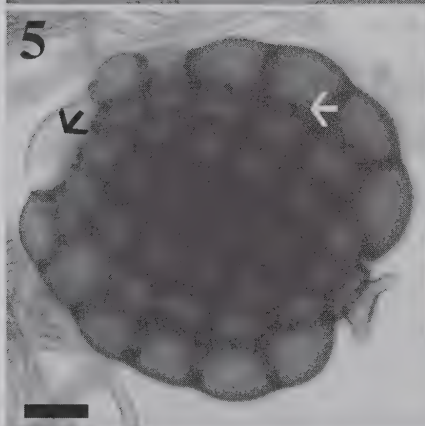
Taxonomic Description

Canalisporium panamense A. Ferrer & Shearer sp. nov.

Figs. 1–11

Coloniae in substrato naturali disseminata, punctiforma, atra, nitida. Mycelium immersum, ex hyphis pallide brunneis, laevibus, ramosis, septatis 2.0–2.5 µm latis compositum. Cellulae conidiogenae in conidiophoris incorporatae, terminales, cylindricus transeus vesiculosae. Conidia solitaria, acrogena, globosa, subglobosa, ovalis, complanata, muriformia, laevia, olivacea brunnea vel brunnea, 6–8 longitudinalibus septis, et 6–8 septis transversis, atris, cellula basali cuneiformia, subhyalina vel pallide brunneis, lumina cellularum canaliculis connexa sed obscura, 50–70 × 46–60 µm (mean= 58.53 × 52.26 µm SD= 6.20 × 3.99µm). Conidiorum secessio rhexolytica.

Figs. 1–6. *Canalisporium panamense*. (Holotype E074-1). 1–5. Stages in conidium formation arranged in a developmental series from slide cultures, white arrow indicates septal canals, black arrow indicates deliquescent apical cell. 6. Hyphae from cultures grown on PDA. Bars= 10 µm.



Etymology *panamense*, in reference to the country (Panama) where this fungus was collected.

Colonies on natural substrate effuse or punctiform, black, shining, consisting of a single or a few conidia (Fig. 7). **Mycelium** immersed in the substrate, composed of septate, branched, subhyaline to pale-brown hyphae, 2.0–2.5 μm wide. **Conidiophores** absent. **Conidiogenous cells** integrated, determinate, terminal, cylindrical, sometimes becoming vesiculate ($2.5 \times 5.0 \mu\text{m}$), hyaline to pale brown; **conidial secession** rhexolytic. **Conidia** solitary, acrogenous, globose, sub-globose or oval, complanate, one-cell thick, thick-walled, muriform, smooth, with dark, 6–8 slightly curved longitudinal septa, and 6–8 transverse septa, some constricted at the septa, olivaceous-brown, to brown, darker at the septa, supported by a small, thin walled subhyaline to light brown, cuneiform basal cell, the number of cells per conidium varies from 50–72, apical row with 4–7 cells, cell lumen connected by canals obscured by dark pigmentation, $50\text{--}70 \times 46\text{--}60 \mu\text{m}$ (mean = $58.53 \times 52.26 \mu\text{m}$, SD = $6.20 \times 3.99 \mu\text{m}$) (Figs. 8–11).

Colonies on PDA, slow growing, attaining a diameter of 0.6 cm in 4 wks at 24 C, brownish-black, compact, with little aerial mycelium; hyphae pale brown, septate, branched, showing chains of swollen cells (torulose chain) up to 7 μm wide (Fig. 6); conidia holoblastic (Figs. 1–5), initially forming 3–7 transverse septa (Figs. 1 & 2), followed by the formation of longitudinal septa (Figs. 3 & 4); conidia are pale olive to brown and become darker at the septa, canals are more visible in immature conidia, before darkening of the septa (Fig. 5). The apical cell of some conidia deliquesce leaving a larger number of terminal cells (Fig. 5). This may explain the variation in the number of apical cells observed on conidia on natural substrates (Figs. 7–11).

Holotype here designated: PANAMA. COLON PROVINCE: Soberania National Park, **Frijoles River**, 9°8'N, 79°43'W, on submerged decorticated wood, 12 January 2003. A. Ferrer E074-1 (ILL).

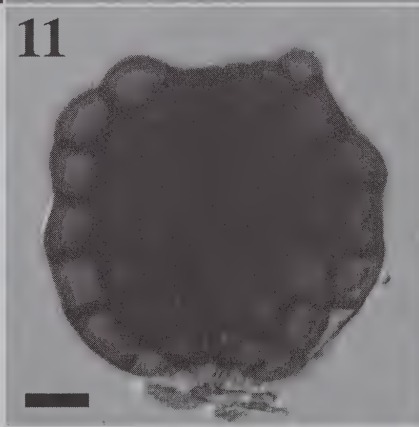
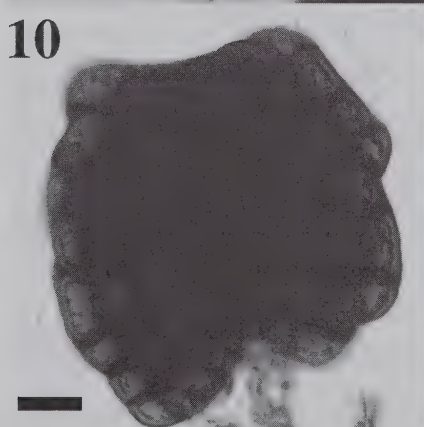
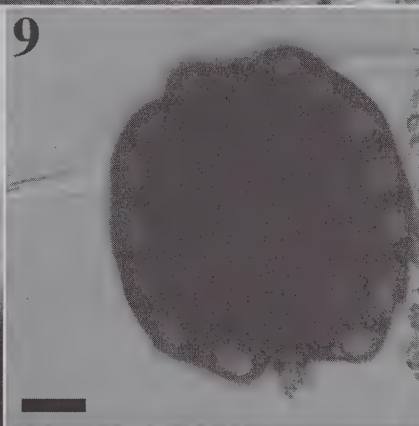
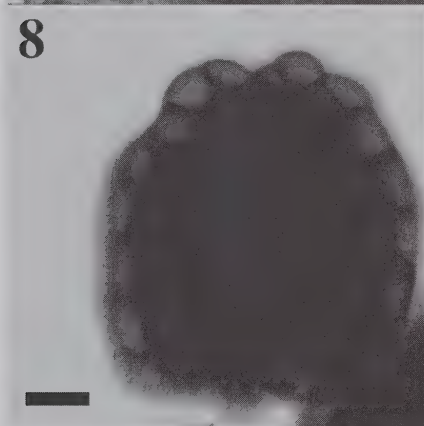
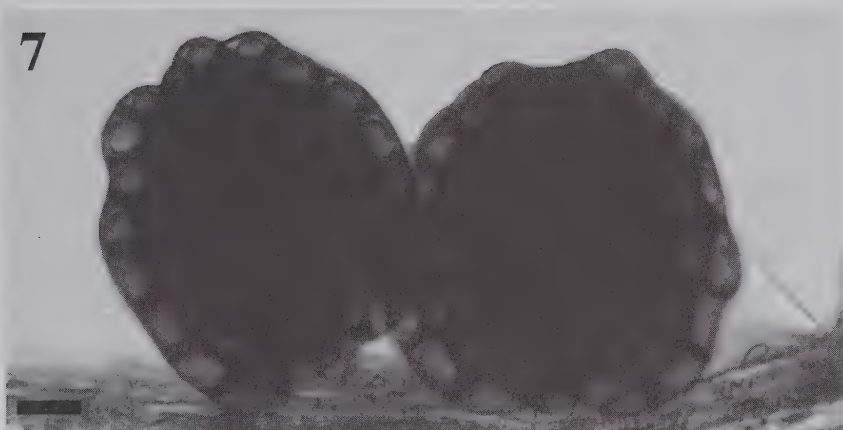
Additional specimens examined: PANAMA: COLON PROVINCE: Soberania National Park, **Frijoles River**, 9°8'N, 79°43'W, on submerged decorticated wood, 12 January 2003. A. Ferrer E074-2; **Limbo River**, 9°09'N, 79°44'W, on submerged decorticated wood, 18 May 2003, A. Ferrer E041-1, E041-2, E041-3, E041-4

Habitat: Saprobic on submerged wood in rivers.

Geographical distribution: PANAMA

Comments: The orderly arrangement of transversal and vertical septa and the presence of narrow canals in connecting adjacent cells in *Canalisporium panamense* (Fig. 5) were the key characters in placing this species in the genus *Canalisporium*. Nonetheless, *C. panamense* differs from other species in the genus in having colonies in the natural substratum formed mostly by effuse conidia that occasionally form small groups. The new species resembles *C. elegans* (Fig. 14) in the morphology of the conidia but differs in the number of conidial septa and dimensions; in *C. panamense*, the majority of the

Figs. 7–11. *Canalisporium panamense*. 7. Close-up of colony on natural substrate (Holotype E074-1), 8–9 Mature conidia from bark (E074-1), 10. Mature conidia from bark (E041-2), 11. Mature conidia from bark (E041-1). Bars = 10 μm .



conidia have 7 (8) longitudinal septa compared to 4 (5) in *C. elegans*; and the conidia of *C. panamense* are longer and wider ($50\text{--}70 \times 46\text{--}60 \mu\text{m}$) compared to the conidia of *C. elegans* ($32\text{--}58 \times 25\text{--}38 \mu\text{m}$). We were able to compare and verify the differences between *C. panamense* and *C. elegans* from different specimens collected from the same area (Fig. 14).

Canalisporium caribense (Hol.-Jech. & Mercado) Nawawi & Kuthub. Mycotaxon 34: 479 (1989) **Figs. 12–13**

≡ *Berkleasmium caribense* Hol.-Jech. & Mercado. Česká Mykologie 38: 99 (1984)

Sporodochia on bark scattered, pulvinate, granular, dark brown, or black, shining. **Mycelium** mostly immersed in the substrate, composed of septate, branched, smooth, pale-brown hyphae, $2.0\text{--}2.5 \mu\text{m}$ wide. **Conidiophores** semi-macronematous, hyaline to very pale brown, $2\text{--}2.5 \times 10\text{--}15 \mu\text{m}$. **Conidiogenous cells** integrated, terminal, determinate. **Conidia** solitary, acrogenous, subglobose to broadly ellipsoidal, complanate, one cell thick, muriform, 4–6 transverse septa, 1 longitudinal septum with visible septal canals, smooth, brown with dark septa, supported by a small, thin walled, pale brown, cuneiform basal cell, $26\text{--}41 \times 20\text{--}32 \mu\text{m}$. Colonies on PDA, slow growing, attaining a diameter of 0.8 cm in 4 wks, dark brown, compact with little aerial mycelium. Sporulation occurred on the strips of banana leaves added to the PDA media.

Specimens examined: PANAMA. COLON PROVINCE: Soberania National Park, **Frijoles River**, $9^{\circ}8'N$, $79^{\circ}43'W$, on submerged decorticated wood, 12 January 2003, A. Ferrer E078-1, E078-2 and E078-3; **Juan Grande River**, $9^{\circ}8'N$, $79^{\circ}43'W$, 12 January 2003 on submerged decorticated wood, A. Ferrer E101-1, and A. Ferrer E101-2 also on submerged corticated wood; **Limbo River**, $9^{\circ}09'N$, $79^{\circ}44'W$, on submerged corticated wood, 18 May 2003, A. Ferrer E034-1 and E034-2. Barro Colorado National Monument, **Conrad Stream**, $9^{\circ}10'N$, $79^{\circ}51'W$, on submerged decorticated wood, 5 July 2004, A. Ferrer E171-1.

Habitat: Saprobic on submerged wood in rivers.

Geographical distribution: Brunei, Cuba, Hong Kong, Kenya, Malaysia, Panama, Philippines, Taiwan, Thailand, Uganda, Vanuata.

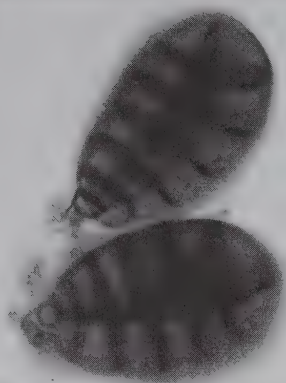
Comments: We obtained numerous collections of *C. caribense* in one forest site, Colon Province, Soberania National Park, and observed the conidial morphology and pigmentation variation previously reported from different localities by Goh et al (1998).

Canalisporium elegans Nawawi & Kuthub. Mycotaxon 34: 479 (1989) **Fig. 14**

Sporodochia scattered, pulvinate, granular, black, shining. **Mycelium** mostly immersed in the substrate, composed of septate, branched, smooth, pale brown hyphae, $2\text{--}3.5 \mu\text{m}$ wide. **Conidiophores** semi-macronematous, subhyaline to pale brown. **Conidiogenous**

Figs. 12–13. Conidia of *Canalisporium caribense* E078-3 and E101-1. Fig. 14. Conidia of *Canalisporium elegans* E042-1. Figs. 15–16. Conidia of *Canalisporium kenyense* E185-2. Fig. 17. Conidia of *Canalisporium pulchrum* E073-1. Black arrows indicate conidiogenous cells. Bars = $10 \mu\text{m}$.

12



13



14



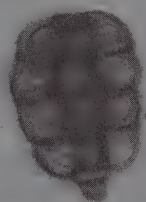
15



16



17



cells holoblastic, integrated, terminal, determinate, cylindrical to globose. **Conidia** solitary, acrogenous, complanate, muriform, 6-8 transverse septa, 4 longitudinal septa, subglobose to oval, smooth, pale-brown to brown with dark septa, supported by a small, thin walled, pale brown, cuneiform, basal cell, septal canals visible (Fig.14), $37.5\text{--}52.5 \times 22.5\text{--}37.5 \mu\text{m}$. Colonies on PDA, slow growing, attaining a diameter of 1.0 cm in 4 wks, dark brown, compact with little aerial mycelium. Sporulation occurred abundantly on the strips of banana leaves added to the PDA media

Specimens examined: PANAMA. COLON PROVINCE: Soberania National Park, **Limbo River**, 9°09'N, 79°44'W, on submerged corticated wood, 18 May 2003, A. Ferrer E042-1; **Frijoles River**, 9°8'N, 79°43'W, on submerged decorticated wood, 12 January 2003, A. Ferrer E106-1; Barro Colorado National Monument, **Gatun Lake**, 9°10'N, 79°51'W, on submerged leaves of *Typha domingensis*, 27 June 2003, A. Ferrer E042-2; **Wheeler Stream**, 9°10'N, 79°51'W, on submerged decorticated wood, 18 August 2004, A. Ferrer E042-3.

Habitat: Saprobic on submerged wood in rivers and on submerged leaves of *Typha* in a lake.

Geographical distribution: Brunei, Malaysia, Panama, Thailand.

Comments: This is the first report of *C. elegans* from the neotropics (Panama); previously, it was thought to be restricted to Asia (Brunei and Malaysia).

Canalisporium kenyense Goh, W. H. Ho & K. D. Hyde. Can. J. Bot. 76: 142 (1998). **Figs. 15-16**

Sporodochia on natural substrate punctiform, black, shining. **Mycelium** immersed in the substrate, hyphae septate, smooth, pale brown, $2 \mu\text{m}$ wide. **Conidiophores** semi-micronematous, cylindrical, smooth, hyaline, $27.5 \times 2 \mu\text{m}$. **Conidiogenous cells** integrated, terminal, determinate. **Conidia** solitary, acrogenous, subglobose to broadly ellipsoidal, one cell thick, thick-walled, muriform, 4-5 transverse septa, 2 longitudinal septa, constricted at septa, smooth, brown to dark brown, three small, hyaline, thin walled basal cells, visible septal channels, $30\text{--}46 \times 22\text{--}30 \mu\text{m}$. Colonies on PDA, slow growing, attaining a diameter of 1.5 cm in 6 wks, dark brown, compact with little aerial mycelium.

Specimens examined: PANAMA. COLON PROVINCE: Barro Colorado National Monument, **Conrad Stream**, 9°10'N, 79°51'W, on submerged decorticated wood, 5 July 2004, A. Ferrer E185-1; **Wheeler Stream**, 9°10'N, 79°51'W, on submerged decorticated wood, 18 August 2004, A. Ferrer E185-2.

Habitat: Saprobic on submerged wood in rivers and streams.

Geographical distribution: Kenya and Panama.

Comments: This is the first report of *C. kenyense* from the neotropics (Panama).

Canalisporium pulchrum (Hol.-Jech. & Mercado). Nawawi & Kuthub. Mycotaxon 34: 475 (1989) **Fig. 17**

=*Berkleasium pulchrum* Hol.-Jech. & Mercado. Ceska Mykologie 38: 96 (1984)

Sporodochia scattered, pulvinate, black. **Mycelium** immersed in the substrate, hyphae septate, branched, hyaline to pale-brown, 2–2.5 μm wide. **Conidiophores** semi-macronematous, cylindrical, smooth, pale brown, $2.5 \times 10\text{--}15 \mu\text{m}$. **Conidiogenous cells** integrated, terminal, determinate. **Conidia** solitary, acrogenous, sub-globose, complanate, one cell thick, muriform, with 3–4 transverse septa, and 2 longitudinal septa, constricted at the septa, smooth, pale brown, supported by a small, thin walled, pale brown, cuneiform, basal cell, visible septal canals, $25\text{--}50 \times 17.5\text{--}35.0 \mu\text{m}$. Colonies on PDA, very slow growing, attaining a diameter of 0.4 cm in 4 wks, dark brown center, black edge, compact with little aerial mycelium

Specimens examined: PANAMA. COLON PROVINCE: Soberania National Park, **Frijoles River**, 9°8'N, 79°43'W, on submerged decorticated wood, 12 January 2003, A. Ferrer E073-1, E073-2, and E073-3.

Habitat: Saprobic on submerged wood in rivers.

Geographical distribution: Australia, Brunei, Cuba, Hong Kong, India, Malaysia, Panama, Thailand, USA.

Comments: This is the first report of *C. pulchrum* from Panama

Discussion

Five species of *Canalisporium* were found in the lowland tropical forests of Panama. Goh et al. (1998) considered some species in this genus to have a pantropical distribution, because they were collected from multiple continents. The most widely distributed and common species of *Canalisporium*, *C. caribense*, has been reported from 11 countries (Goh et al. 1998), and was also the most common species in this study, and found at four rivers.

In contrast to our findings for lowland forests (50–100 m elevation), no *Canalisporium* species were encountered in our sampling of three montane forest streams at 1000 m elevation. This suggests that species of *Canalisporium* may be restricted to warm tropical environments. One exception, however, is *C. pulchrum*, which has been collected from the Great Smoky Mountains National Park, USA (H. A. Raja, personal communication).

Acknowledgements

We would like to thank Dr. Somsak Sivichai and Prof. C. J. K. Wang for reviewing the manuscript prior to submission. We would like to thank to Jim Dalling, Judith Sousa, and Andrea Pabon for their help with fieldwork. Appreciation is expressed to the STRI for their logistic support to collect in Panama. Financial support by the National Science Foundation (NSF Grant No. DEB 0316496) is gratefully acknowledged.

Literature Cited

- Cai L, Zhang K, McKenzie EHC, Lumyong S, Hyde KD. 2003. New species of *Canalisporium* and *Dictyosporium* from China and a note on the difference between these genera. *Cryptogamiae Mycologiae* 24: 3–11.

- Goh TK, Ho WH, Hyde KD, Whitton SR, Umali TE. 1998. New records and species of *Canalisporium* (Hyphomycetes), with a revision of the genus. Can J Bot. 76: 142-152.
- Goh TK, Hyde KD. 2000. A new species of *Canalisporium* from Australia. Mycologia 92: 589-592.
- Ho WH, and Hyde KD. 2004. A new type of conidial septal pore in fungi. Fungal Diversity 15: 171-186.
- Holubová-Jechová V, Mercado Sierra A. 1984. Studies on Hyphomycetes from Cuba II. Hyphomycetes from the Isla de la Juventud. Česká Mykologie 38: 96-120.
- Nawawi A, Kuthubutheen AJ. 1989. *Canalisporium*, a new genus of lignicolous hyphomycetes from Malaysia. Mycotaxon 34: 475-487.
- Sivichai S. 1999. Tropical freshwater fungi: their taxonomy and ecology. Ph.D. dissertation. University of Portsmouth, Portsmouth, England.

***Amanita*—distribution in the Americas with comparison to eastern and southern Asia and notes on spore character variation with latitude and ecology**

RODHAM E. TULLOSS¹

ret@njcc.com

P. O. Box 57, Roosevelt, New Jersey 08555-0057, USA

This paper is dedicated to my generous mentor, Dr. Cornelis Bas of Leiden.

He transformed *Amanita* taxonomy.

Abstract—Similarity of lists of taxa for *Amanita* sections *Amanita*, *Vagidae*, and *Lepidella* is computed for lists from six Western Hemisphere regions within the natural ranges of *Quercus* and the *Pinaceae*—Prov. Québec, Canada; New Jersey and Long Island, USA; central Mexico; Costa Rica; the Chiricahua Mountains, USA; and Andean Colombia. For the first two sections, the pattern of distribution reflected in similarity measures is compared to similarity measures for areas of southern and eastern Asia in which *Quercus* and the *Pinaceae* are also major symbionts of *Amanita*. Data suggest higher endemism in the American regions than in the Asian ones. Factors that may influence this difference are discussed. Biogeographic affinity was computed for the Western Hemisphere nations with regard to Mexico and for the east Asian regions with regard to southwestern China. Variation of three spore characters (amyloidity, shape, and size) with latitude and habitat is examined and apparent trends reported. Hypotheses are offered for environmental pressures contributing to evolution of spore size and shape and for biogeography of taxa. Data supporting rejection or acceptance of hypotheses are reviewed. The combination *Amanita floridana* is validated.

Key words—*Amarrendia*, central Africa, South America, *Torrendia*, tropical habitat

It is now conjectured that there are 900 to 1,000 species of *Amanita* Pers. worldwide (Bas 2000; Tulloss 2000a). Of these, half or slightly more have been described. Half or more of the conjectured species are believed to occur in the Western Hemisphere. Data and specimens from 150 years of mycological collecting (beginning with the holotype of *A. flavorubens*) were examined to elucidate patterns of distribution of *Amanita* taxa in the Americas. Nevertheless, so many undescribed taxa are known or expected to be found that this paper must be considered provisional and the subject requires revisiting in the future.

1. Research Associate (hons.), the New York Botanical Garden (NY).

Materials and methods

1. Regions of study

Six Western Hemisphere regions within the combined natural ranges of *Quercus* and the *Pinaceae* were selected for comparison of their suites of species in *Amanita* sections *Amanita*, *Validae* (Fr.) Quél., and *Lepidella* (E. J. Gilbert) Corner & Bas: (1) Prov. Québec, Canada; (2) New Jersey and Long Island, New York, USA (NJ/LI); (3) Chiricahua Mountains, Cochise Co., Arizona, USA (AZ); (4) central Mexico (CTR. MEX.—states of Hidalgo, Mexico, Michoacan, Puebla, Tlaxcala, and Veracruz); (5) the Cordillera Talamanca, Costa Rica (CR); and (6) Andean Colombia (COL). The regions of interest span approximately 50 degrees of latitude (5°N to 55°N) and approximately 40 degrees of longitude (60°W to 100°W).

Past work concerning distribution on a north-south cline in the Americas north of and including Andean Colombia is summarized by Halling (2001).

2. Selection of taxonomic groups for comparison

Sections of the genus were selected for apparent relative stability of the lists of taxa known from the regions of interest—for the current relatively slow rate of growth in the size of most of those lists (Tulloss unpub. data). Unfortunately, while known to some considerable extent, central Mexico has probably not been as thoroughly explored as the other regions of study; collections from the region have not been as thoroughly revised as in the other regions; and its counts of taxa are probably underestimated—perhaps significantly so.

Sections *Amanita* and *Lepidella* have had monographic treatment in the last 35 years—North American taxa of the former by Jenkins (1977) and worldwide taxa of the latter by Bas (1969). The remaining three sections of the genus are either in great flux taxonomically with many undescribed species (section *Vaginatae* (Fr.) Quél. and to a lesser degree section *Amidella* (E. J. Gilbert) Konrad & Maubl.) or are confusing at present due to inadequate understanding of a significant number of the species (*Phalloideae* (Fr.) Quél.). Moreover, some apparently useful macrochemical characters cannot be checked on dried material.

3. Compilation of lists of taxa from the study regions

Lists of taxa for the study were based on review of exsiccata to the degree possible—with limited dependence on the literature. Then-current keys to taxa in several of the regions of interest appear as appendices in (Tulloss 1998a).

Resources upon which I relied in part for the data concerning Québec were due to J. Deprés et al. (2002), Y. Lamoureux (1999; pers. corresp.), and R. Pomerleau (1980).

Material examined from Arizona comprises, for the most part, collections made as part of the Chiricahua Mycoflora Project, organized and directed by J. A. Menge and F. H. Nishida. I have access to the *Amanita* collections from the five+ year project. Many of these collections were annotated by me when fresh.

Material examined from Mexico primarily comes from ENCB, FCME, LBUG, MEXU, NY, RET, TLXM, and XAL and represents the work of a large number of collectors. Among the many recent collections examined most were made by or with A. Estrada-Torres, A. Kong-Luz, and A. Montoya-Esquivel and other faculty and students at Universidad de Tlaxcala. To date, my own field work has been carried out in the states of Hidalgo, México, and Tlaxcala. I'm also grateful to have received as a gift the poster presented by Herrera Fonseca and Guzmán-Dávalos (2002).

Material examined from Costa Rica is largely from the Cordillera Talamanca and was collected by A. E. Franco-Molano, L. D. Gómez, R. E. Halling, J. L. Mata, G. M. Mueller, R. Singer, R. E. Tulloss, and others. I have also received a collection of duplicates from InBio courtesy of M. Mata and a number of *Amanita* collections from the Área de Conservación Guanacaste (on loan from F and NY). Further, I had full access to Singer's notes on *Amanita* in the region (F).

Material examined from Colombia includes collections revised for the study of *Amanita* in the Colombian Andes by Tulloss et al. (1992b). Material of a few taxa not treated in that work, largely collected by A. E. Franco-Molano (COL), has also been revised.

To provide a second model of geographically connected regions with a high degree of similarity in suites of species in the selected sections, similarity was computed for lists of taxa from (1) Japan, (2) southwestern China, (3) the states of Himachal Pradesh and Uttarakhand, India; and (4) the Northwest Frontier Province, Pakistan. The Asian regions selected span approximately 25 degrees of latitude (20°N to 45°N) and approximately 75 degrees of longitude (70°E to 145°E).

The lists for Japan and China are based on some personal review of material and, largely, on the following works: Bas (1969), Bas and Hatanaka (1984); Chen et al. (2001); Hongo (1953, 1957, 1959, 1961, 1967, 1969, 1970, 1971, 1974a, 1974b, 1975, 1977, 1978, 1982, 1983); Hongo and Yokoyama (1978); Imai (1933, 1938, 1939); Imazeki and Hongo (1957, 1965, 1987); Imazeki, Otani and Hongo (1988); Imazeki and Toki (1965); Nagasawa and Hongo (1985); Nagasawa and Mitani (2000); Oda et al. (2000, 2001); Tulloss and Bhandary (1992), Tulloss et al. (1992a), Yang (1994, 1997, 2000a, 2000b, 2001, 2002a, 2002b); Yang and Chen (2003); Yang and Doi (1999); Yang, Zang and Yuan (2000); and Yang and Zhang (2002).

The lists for India are based on examination of exsiccata and a conservative reading of Indian literature as recorded in (R. P. Bhatt et al. 2003). Material examined from India, besides collections cited by Kumar et al. (1990) and Tulloss et al. (2001), were collected by the authors of those works or were cited by V. K. Bhatt et al. (1999), were cited in the doctoral thesis of V. K. Bhatt, were collected by S. L. Stephenson (deposited in BPI), or are under examination as part of current research of K. C. Semwal with Tulloss and others.

The lists for Pakistan come from recent work of Tulloss et al. (2001) and material sent to Tulloss by R. Boehne and K. Nazir.

Data for central Africa was largely obtained from Bas (1969; 1982), Beeli (1935), Buyck (1994), Gilbert (1940-41; 1941), Härkönen et al. (1994), Heim (1936; 1940),

Pegler (1978), Pegler and Shah-Smith (1997), Walley (1996), Walley and Verbeken (1998a; 1998b), and my own research. Many collections from the region were provided to me by D. Arora.

Collections were examined from many herbaria including the following: ALA, BAFC, BPI, C, COL, CSU, CUP, CUVC, DAOM, F, FH, ENCB, FCME, GUH, HKAS, HMAS, HONGO, HPUB, HUA, K, L, LAH, LBUG, MEXU, MICH, NY, NYS, O, PC, PM, PSO, RET, SFSU, TLXM, TNS, UBC, UCB, USJ, WTU, and XAL.

In the tables of raw data (Appendix), “+” indicates that a species is present in a given region of interest; and “i” indicates that a species may be present, but is known to be (or possibly is) introduced.

4. Methods for computing list similarity and biogeographic affinity

The similarity metric applied is the tripartite similarity index of Tulloss (1997) in the version now available on the internet (Tulloss and Tulloss 2004a; 2004b). The value of the metric ranges from 0 through 1 inclusive. The value 0 indicates no elements in common between two compared sets, and the value 1 indicates complete identity between two compared sets. This metric and the supporting worldwide web pages are implemented in HTML, PHP, and a PostgreSQL database hosted in the XAPServer environment.

Biogeographic affinity is often measured using the Simpson coefficient. The purpose of the computation is to compare a list from a region under study with a “canonical” list for another region. Biogeographic affinity is not a measure of similarity (Tulloss 1997) because the Simpson coefficient is nonlinear (Hayek 1994) and ambiguous. The Simpson coefficient has the potential for reversing the comparison depending on the relative size of the lists being compared. I prefer simply to treat biogeographic affinity as the percentage of list items in the study region that are list items in the canonical list. This produces the result desired from the Simpson coefficient without the ambiguous possibilities ever arising. The size of the canonical list plays no direct role in the computation (another reason why, in my opinion, biogeographic affinity is not a workable similarity metric).

5. Matters of presentation

Herbaria name abbreviations are conformant with Holmgren, Holmgren and Barnett (1990), with the exception of HKAS (herbarium of the Kunming Institute of Botany, Academia Sinica, PRC), HONGO (personal herbarium of T. Hongo), HPUB (herbarium of the Department of Biosciences, Himachal Pradesh University, Simla, India), RET (the author’s herbarium) and TLXM (herbario del Laboratorio de Micología, Universidad de Tlaxcala, Tlaxcala, México).

Spore shape naming conventions follow Bas (1969: 311). **Q'** stands for the average ratio of length/width for all spores measured for all specimens examined of a given taxon. In *Amanita*, the values of this variable range from about 1.03 to about 3.50. **Q** stands for the length/width ratio of a single spore.

Author citations for all *Amanita* taxa from the regions of study, except supraspecific taxa, are listed in appendix tables of this paper. Author citations for species not from the regions of study will be found in the body of the paper. Abbreviations in author citations follow Kirk and Ansell (1992).

Road map to this paper

There are four components to this paper. They are dealt with at different lengths as appropriate according to available data.

The first deals with similarity and biogeographic affinity based on the lists of taxa of the selected subsections in the regions of study. This component of the paper is concerned with distribution, relations of sets of taxa from different regions (biogeography), vicariance, and endemism.

The second topic of the paper is dealt with in brief and concerns the distribution of the two subgenera of the genus—*Amanita* (defined by the taxa's having inamyloid spores) and *Lepidella* (E. J. Gilbert) Veselý *emend.* Corner & Bas (defined by the taxa's having amyloid spores).

The third topic of the paper concerns the apparent relationship of spore shape to latitude within the genus *Amanita*.

The fourth topic of the paper concerns the apparent reduction in spore size in the genus *Amanita* in lowland, primary tropical forest with leguminous ectomycorrhizal trees that dominate in scattered groves or occur singly in an otherwise arbuscular-mycorrhizal matrix—as described by Henkel et al. (2002) and Henkel (2003).

Some hypotheses of evolutionary advantages that might be granted by the trends reported are discussed in the third and fourth parts of the paper. These topics are presented as possible areas for further study.

Similarity & biogeographic affinity—Americas and Asia

Appendix Table 1 lists 26 taxa (including unpublished taxa) of *Amanita* section *Amanita* known from the combined regions of interest. A significant number of the taxa are believed to be good species, but have not been formally described. These entities are simply given alphanumeric codes consistent with my earlier publications, such as the keys in (Tulloss 1998a).

Table 1 provides a summary of the similarity relationships embedded in the data of Appendix Table 1 by displaying a matrix of the similarity metrics for all pairs of the six regions under consideration. Each cell of the matrix that represents a distinct comparison contains a triple of numbers and, below them, a similarity measure. The numbers represent (from left to right) the number of taxa occurring in both regions, the number of taxa occurring in the first region and not the second, and the number of taxa occurring in the second region and not the first. The order of the last two values is not material because of symmetry in the similarity metric used. The reader can check on list sizes in the appendix tables.

Appendix Table 2 presents the raw presence/absence data for the 33 taxa of *Amanita* section *Validae* known from the regions of interest and has the same format as Appendix Table 1. Table 2 provides the similarity measures for pairs of regions based on the presence/absence data of Appendix Table 2 and has the same format as Table 1.

Table 3 and Appendix Table 3 are similarly related and similarly formatted and present data for 47 species of *Amanita* section *Lepidella*.

The total number of taxa for which data are presented is 106.

Table 1. Regional similarity—*Amanita* sect. *Amanita* in Americas

	NJ/LI	AZ	QUÉBEC	CTR. MEX.	CR	COL
NJ/LI	-	0	[10,0,5] 0.74	[2,13,7] 0.11	[1,4,14] 0.12	0
AZ		-	0	[2,2,7] 0.27	[2,2,3] 0.45	[2,2,0] 0.58
QUÉBEC			-	[1,8,9] 0.11	[1,4,9] 0.12	0
CTR. MEX.				-	[3,6,2] 0.39	[2,0,7] 0.29
CR					-	[2,3,0] 0.49
COL						-

1. *Amanita* section *Amanita* in the Americas

With regard to *Amanita* section *Amanita*, Appendix Table 1 and Table 1 indicate that while the Québec and NJ/LI regions are the most species-rich regions and share a relatively large number of taxa, in the current state of knowledge, they share no taxa with the Arizona and Colombian regions. While the Arizona region has only four known taxa in section *Amanita*, it shares two of these with all three regions to its south; and, since these regions also have relatively few known taxa in the section, the similarity metric generates relatively high values in the three cases.

The facts that the Québec and NJ/LI regions have the largest lists and that the measure of similarity between their lists is so high (0.74)—the highest measure of similarity for any of the pairs of lists reviewed for this paper—may be related to a number of factors including the geographical proximity of the two regions, extended history of mycological study in those regions, and the partial overlap of forest habitat types. In particular, the Northern Hardwood-*Tsuga* forest type is present in northwestern New Jersey as well as being common in southern Québec.

Only the section *Amanita* lists for the Mexican and Costa Rican regions share at least one taxon with lists of taxa of every other region. This is reflected in Table 1 by the following: Cells in rows and columns labeled with the two regions' names contain no

entries with a similarity measure of zero. It appears that Mexico and Costa Rica may represent an intersection of distributions of sets of taxa in section *Amanita*—one associated with eastern North America and another with western North America.

Examining biogeographic affinity to Mexico, the computed values are as follows: Prov. Québec, 10%; NJ/LI 13%; Chiricahua Mountains, 50%; Costa Rica, 60%; Andean Colombia, 100% (1 of 2 taxa is possibly introduced). Note that the number of known taxa in the last three regions is quite small. It appears that areas of relative low diversity (Chiricahua Mountains and Andean Colombia) show less endemism in section *Amanita*. To highlight another set of biogeographic relations, the computations can be repeated to show affinity to the NJ/LI region of study (the most heavily studied by the author): Prov. Québec, 100%; Chiricahua Mountains, 0%; central Mexico, 22%; Costa Rica, 20%; Andean Colombia, 0%.

Table 2. Regional similarity—*Amanita* sect. *Validae* in Americas

	NJ/LI	AZ	QUÉBEC	CTR. MEX.	CR	COL
NJ/LI	-	[1,2,18] 0.07	[7,1,12] 0.45	[2,7,17] 0.13	0	0
AZ		-	[1,7,2] 0.16	[3,0,6] 0.42	0	0
QUÉBEC			-	[2,6,7] 0.25	0	0
CTR. MEX.				-	[1,8,4] 0.13	[1,8,3] 0.14
CR					-	[2,3,2] 0.45
COL						-

2. *Amanita* section *Validae* in the Americas

In *Amanita* section *Validae* (Appendix Table 2 and Table 2), the Québec, NJ/LI, and Mexican regions are most species-rich. As in section *Amanita*, there is a relatively high degree of similarity between the section *Validae* lists of taxa for the first two areas.

Amanita flavorubens is a curious species from the point of view of this study in that it is the only one in the sections of *Amanita* examined that is present in both the north-eastern North American and southwestern USA study areas.

Table 2 reveals less similarity among regions of study than in the case of section *Amanita*. In other words, there appears to be a higher degree of endemism in section *Validae* than in section *Amanita*. The zeros in the “CR” and “COL” columns reflect the lack of known taxa shared between the lists of taxa for the two most southerly regions examined and the three most northerly. Once more, Mexico appears to repre-

sent a "cross roads" for distributions of taxa of northeastern North America and taxa of the southwestern USA.

With regard to biogeographic affinity to the Mexican region of study, the computations yield the following: Prov. Québec, 33% (note: *one of three* species); NJ/LI, 11%, Chiricahua Mountains, 100%; Costa Rica, 20%; Andean Colombia, 25%. Biogeographic affinity to the NJ/LI region of study is computed for purposes of comparison: Prov. Québec, 88%; Chiricahua Mountains, 33% (note: *one of three* species); Mexico, 22%; Costa Rica, 0%; Andean Colombia, 0%. The known number of species of section *Validae* is low for most of the regions of study (3 to 9 species in all regions except NJ/LI where, after 25 years' collecting by the author, 19 named or undescribed taxa have been recorded).

Table 3. Regional similarity—*Amanita* sect. *Lepidella* in Americas

	NJ/LI	AZ	QUÉBEC	CTR. MEX.	CR	COL
NJ/LI	-	0	[3,0,23] 0.16	[4,22,12] 0.18	[1,25,4] 0.05	0
AZ		-	0	[2,4,14] 0.16	0	0
QUÉBEC			-	[1,2,15] 0.08	0	0
CTR. MEX.				-	[1,15,4] 0.08	0
CR					-	[1,4,1] 0.25
COL						-

Readers familiar with the study of *Amanita* in Andean Colombia by Tulloss et al. (1992b) may remark the absence of *Amanita flavoconia* var. *sinapicolor* Tulloss, Ovrebo & Halling from Appendix Table 2. Additional field observations in Costa Rica have convinced Tulloss, Halling and G. M. Mueller (unpub. data) that the supposed variety *sinapicolor* simply comprises collections of var. *inquinata* that have been exposed to direct sunlight in montane habitat resulting in loss or alteration of the red-dish pigment component in the pileus and some desiccation, with the latter, in turn, causing incompletely inflated (hence, more nearly globose) spores. Thus the two characters thought to distinguish the varieties are now interpreted to be based on meteorological, not genetic, factors. The cited authors will propose reduction of *A. flavoconia* var. *sinapicolor* to taxonomic synonymy with *A. flavoconia* var. *inquinata*.

3. *Amanita* section *Lepidella* in the Americas

In examining distribution of taxa in *Amanita* section *Lepidella*, we have a larger number of taxa (47) with which to deal than in the previous cases. They appear to be con-

centrated, for the most part, between and including the NJ/LI and central Mexican regions of study—temperate to subtropical areas. The work of Bas (1969) provided a foundation for the systematics of section *Lepidella* that is superior to that available for any other section of the genus. Since 1969, the naming of new species has often made good use of Bas' information and his methodology; hence, the section still remains in relatively good order taxonomically. From Table 3 and Appendix Table 3, it is immediately clear that the small sets of species in Colombia and Costa Rica share few members (to date, only one—*Amanita polypyramis*, known from Costa Rica) with the sets from the other regions.

With regard to biogeographic affinity to Mexico, the following values are computed: Prov. Québec, 33% (note: one of three species); NJ/LI, 15%; Chiricahua Mountains, 33%; Costa Rica, 20%; Andean Colombia, 0%. Again, the extensive study of the NJ/LI region by a taxonomist focused on *Amanita* probably has an unbalancing effect on this data. It should be expected that the percentages for the study regions (possibly, least likely for Prov. Québec and Andean Colombia) will increase as more is learned of the undoubtedly large Mexican mycota.

Biogeographic affinity to the NJ/LI region of study is computed for purposes of comparison: Prov. Québec, 100%; Chiricahua Mountains, 0%; central Mexico, 25%; Costa Rica, 20%; Andean Colombia, 0%.

No region has at least one species in common with every other as in the previous cases, but Mexico still maintains its condition of sharing at least one taxon with the three regions to its north and with Costa Rica to the south.

Because there is considerable reliable information about species in section *Lepidella*, it is possible to project what further distribution overlaps between the study regions may be demonstrated in the future. I suspect that all currently known Costa Rican taxa may eventually be demonstrated to occur in Mexico. As to a greater degree of similarity between the Mexican region and regions of study to the north, it is very likely that the set of taxa common to the lists for the NJ/LI and Mexican regions will be expanded after further study. For example:

- Visits to sites in central Mexico have sometimes quickly yielded several species of section *Lepidella* that are familiar from collecting areas in New Jersey—e.g., *A. atkinsoniana*, *A. daucipes*, and *A. polypyramis*. I also have found a number of collections (given alphanumeric codes) that appear to be possible vicariants of taxa known from the New Jersey region (see Appendix Table 3). These observations incline me to believe that my experiences will be repeated on future collecting trips.
- *Amanita nauseosa*, apparently a taxon of Caribbean origin (Tulloss unpub. data) has been found as far north as Baltimore, Maryland, USA (Tulloss unpub. data), but not yet in New Jersey.
- Specimens strongly suggesting "*A. talamancae*" have been collected in northern New York State (Tulloss unpub. data).

There are several taxa in the present list for section *Lepidella* that appear to occur without any woody ectomycorrhizal symbiont: "*A. eremites*," "*A. macerisolum*," *A.*

nauseosa, *A. prairicola*, "*A. savannae*," and *A. thiersii*. These belong to *Amanita* subsection *Vittadiniae* Bas. Such taxa occur in a diversity of habitats available in regions of study beyond those for which they are listed: high altitude desert, wet savanna, subtropical and tropical lowlands, high elevation prairies, gardens, and lawns. In the Western Hemisphere, species in the subsection occur from western Canada (Tulloss unpub. data) to Patagonia (Bas 1969; Tulloss unpub. data). *Amanita thiersii* demonstrates a connection to Puebla edo., México from an area stretching at least from Illinois (W. Sundberg pers. corresp.) to eastern Texas (Bas 1969). A number of taxa in subsection *Vittadiniae* occurring in the USA overlap the range of *A. thiersii* in Texas and, hence, might well be found further south. Among these are *A. silvifuga* Bas (1969) and *A. subcaligata* (A. H. Sm. & P. M. Rea) A. H. Sm. ex Tulloss in Volk & Burds. (= *A. salmonea* Thiers) (Bas 1969; Tulloss unpub. data).

4. Comparison to studies of other groups of basidiomycetes in central Mexico and the U.S.

Dr. J. Cifuentes (pers. corresp.) called to my attention other studies that report taxa shared by regions of central Mexico with the eastern and western mycota of the U.S.

In a section of his doctoral thesis, A. Estrada-Torres (1994) discusses biogeographical issues concerning the *Gomphaceae*. He notes that taxa studied in the state of Tlaxcala, Mexico, include several groupings associated with regions to the north. He expresses the relations in terms of biogeographical affinity: 21.6% of the taxa studied are classed as widely distributed in the Northern Hemisphere; 13.5%, as being shared only with the western U.S.; 8.1%, as being shared only with the eastern U.S.; and the remainder, as elements known, at that time, only from his region of study.

In the doctoral thesis of Cifuentes (1996), biogeographical affinities of stipitate hydnums of the eastern (7.5%) and western (also, 7.5%) regions of the U.S. were calculated with regard to study areas in central and southern Mexico. Affinities were also recognized with Europe and tropical America. In addition endemic and widespread Northern Hemisphere groupings were recognized. Recent studies have indicated that at least some of the taxa formerly treated under European names have proved to be endemic (Cifuentes, pers. corresp.)

Both studies addressed regions of central Mexico (exclusively in the first case). Both studies demonstrated biogeographical affinities to central Mexico of the eastern and western U.S. Both studies demonstrated a group of apparent Mexican endemics, and continuing studies have increased the number of endemics. Hence, the pattern present in the *Amanita* data of this paper echoes previous results in very distinct groups of mycorrhizal basidiomycetes.

5. Additional comments regarding the American regions of study

In the three sections examined, the lists of taxa of the two northernmost regions are most similar to each other; and the same is true for lists of taxa of the two southernmost regions.

The greatest diversity of symbionts for *Amanita* apparently occurs between the NJ/LI region and central Mexico.

Of the regions studied, the Chiricahua Mountains show the strongest biogeographical relationship to central Mexico. The Chiricahua Mountains are well known for their floristic link to Mexico. Many of the species of pine and oak present in the Chiricahuas are Madrean species at the northern limit of their mainly Mexican distribution (Elmore 1976; Miller and Lamb 1985; Perry 1991). This is especially true in the Pinon-Juniper and Pine-Oak belts as identified by Elmore (1976)—4,500 to 8,000 feet elev. The mountains are well known among ornithologists for their providing an opportunity to view bird species such as the Elegant Trogon (*Trogon elegans*, the most northerly occurring taxon of the Trogonidae) at the extreme northern limit of their ranges (e.g., Farrand 1983). The Sierra Madre Occidentale apparently serves as a biogeographical link between the Chiricahua Mountains and the central Mexican regions of study. The upper elevations in the Chiricahuas are largely linked to the north and west biogeographically. It is worth noting that at least three taxa present in the Chiricahuas (one per section treated in this paper) have northern limits in the West far to the north of Cochise Co.—*A. muscaria* subsp. *flavivolvata*, *A. novinupta*, and *A. smithiana* (see following bullet list). The latter two appear to be rare in the Chiricahua Mountains—even during recent years of record rainfall.

Based on current knowledge, a relatively small number of studied *Amanita* taxa in the three sections examined (10 taxa (9 species) of 106 taxa considered) are known to be rather widely distributed naturally within the combined natural ranges of *Quercus* and the *Pinaceae* in the Americas:

- *atkinsoniana* (amyloid spores) Québec at least to central Mexico (Michoacan edo.)
- *citrina sensu auct. amer.*, (amyloid spores) Québec at least to central Mexico (Hidalgo edo.)
- *farinosa* (inamyloid spores) Québec at least to Costa Rica
- two varieties (taken together) of *A. flavoconia* (amyloid spores) Québec to Andean Colombia
- *muscaria* subsp. *flavivolvata* (inamyloid spores) ranging from southern Alaska (Tulloss unpub. data) and the USA coast of the Gulf of Mexico at least to Costa Rica in the wild, with other occurrences (possible or certain introductions) southward (e.g., Tulloss et al. 1992b; Tulloss unpub. data on Argentine collections) and at least one site (possible introduction) in Massachusetts (Tulloss unpub. data)
- *novinupta* (amyloid spores) southwestern Canada to central Mexico (Tulloss and Lindgren 1994; Tulloss unpub. data)
- *polypyraxis* (amyloid spores) New Jersey to Costa Rica (Morales-Torres et al. 1999; Tulloss, Halling and G. M. Mueller unpub. data)
- *smithiana* (amyloid spores) southwestern Canada to central Mexico (Tulloss and Lindgren 1992; Tulloss unpub. data)

- *xylinivolva* (inamyloid spores) Arizona to Andean Colombia (Tulloss et al. 1992b; Tulloss 1998; Tulloss unpub. data).

6. Southern and eastern Asian similarity and biodiversity

For purposes of comparison and contrast, lists of taxa were examined for a group of relatively well-known regions of study in southern and eastern Asia distributed within a narrower range of latitude and a significantly greater range of longitude as noted in the "Methods" section, above: Japan, southwestern China (SWC), Himachal Pradesh and Uttaranchal states in India (HP/UT), and the Northwestern Frontier Province of Pakistan (NWFP).

Table 4. Regional similarity—*Amanita* sect. *Amanita* in Asian regions

	Japan	SWC	HP/UT	NWFP
Japan	-	[6,5,7] 0.50	[4,7,6] 0.40	0
SW China		-	[2,8,11] 0.17	0
India (HP/UT)			-	[1,9,1] 0.14
Pakistan (NWFP)				-

The raw data tables for this set of regions are Appendix Table 4 (24 taxa of *Amanita* section *Amanita*) and Appendix Table 5 (10 taxa of *Amanita* section *Validae*). Their format is the same as that of Appendix Table 1. Table 4 and Table 5 provide the corresponding matrices of similarity measures and follow the format of Table 1.

Biogeographic affinity to southwestern China in the case of *Amanita* section *Amanita* is as follows: Japan, 55%; Indian region of study, 20%; NWFP, Pakistan, 0%. Biogeographic affinity to southwestern China in the case of *Amanita* section *Validae* is as follows: Japan, 100%; Indian region of study, 67%; NWFP, Pakistan, 100%. Yang, Zang, and Yuan (2000) briefly treat the biogeographic affinity of the amanitas of southwestern China to those of Japan.

In *Amanita* section *Validae*, we have the interesting situation of two species—*A. flavipes* and *A. orsonii* distributed over nearly 75 degrees of longitude in the North Temperate Zone—a range extending over more than 7,200 km. (For comparison, a species with circumarctic distribution would extend 15,800 km around the 65th parallel if the distance between the coasts of Greenland and Norway is omitted.)

Note: Prior to going to press, I received a copy of an interesting article by Zhang et al. (2004) that provides molecular and morphological evidence that there may be more than one taxon now classified under the name *A. flavipes*.

The collecting regions all fall within a belt of forest (now extensively fragmented locally) including *Quercus* and several genera of the *Pinaceae* as major components. The *Times Atlas* (1985) characterizes these forests as Subtropical Forest, Monsoon

Forest, Tropical Rain Forest, and Dry Tropical Forest. The relative continuity of available symbionts in a few genera and the restriction to latitudes north of the Tropic of Cancer both may be factors that permit the two species of section *Validae* cited above to have such an extended range.

Table 5. Regional similarity—*Amanita* sect. *Validae* in Asian regions

	Japan	SWC	HP/UT	NWFP
Japan	-	[5,3,0] 0.70	[3,2,3] 0.55	[2,0,3] 0.49
SW China		-	[4,2,4] 0.56	[2,0,6] 0.32
India (HP/UT)			-	[2,4,0] 0.42
Pakistan (NWFP)				-

The relatively high values for measures of similarity in Table 5 reflect a lower degree of endemism (based on current knowledge) for species of section *Validae* in the Asian regions of study than is observed in the Western Hemisphere regions. This is strongly supported by the high values for biogeographic affinity to southwestern China computed for section *Validae*. On the other hand, my lack of familiarity with the undescribed taxa of the Asian study regions also may have an effect on the species counts and, hence, the computations. (Compare the low number of provisional names and species “codes” in the east Asian appendix tables with the greater frequency of such names in the appendix tables including Western Hemisphere taxa.)

7. The Central American biological “bottle-neck”

Among factors which may be at play in the more limited similarity of lists of taxa in the Western Hemisphere group of study regions, are the absence of naturally occurring *Pinus* in Costa Rica and Colombia, the geologically recent appearance of the isthmus including Costa Rica, the *more* recent migration of *Quercus* into Colombia, and the fact that the selected regions of study extend from well north of the Tropic of Cancer to well south of it. It has been repeatedly observed that both *Quercus* and *Amanita* species numbers are markedly reduced—by about an order of magnitude—between Mexico and Costa Rica. Mexico has between 112 species of *Quercus* according to Schandly as cited by Miller and Lamb (1985) and 150 species according to the work of Rzedowski as cited by Kappelle (1995). Costa Rica has less than 12 or up to 17 species of *Quercus* according to several authorities cited by Kappelle (1995).

The absence of naturally occurring pine south of Nicaragua and El Salvador (Perry 1991) undoubtedly also has a severe effect on the species richness of *Amanita* in Costa Rica and Colombia. Human predation and severe bark beetle epidemic attacks brought pine in El Salvador to the point where it “practically disappeared” toward the end of the last century (Perry 1991: 211).

The *Amanita* taxa with long north-south ranges are clearly capable of forming mycorrhizae with both *Quercus* and members of the *Pinaceae* (and sometimes with taxa in other families of plants as well). *Amanita muscaria* subsp. *flavivolvata*, with its very extended natural range is one such taxon and *A. flavoconia* is another.

The nineteenth century naturalist, Thomas Belt, recorded that about 80% of the birds he collected in Nicaragua were species known at that time from the region to his south, but not from the Atlantic forest to his north (Belt, 1874: 377-378); and he reflects on this interruption in distribution. He describes the end of the “great Atlantic forest” as being to the north and west of an intrusion of the Gulf of Honduras into the mainland of the isthmus along with the presence of the valleys of Humuya and Goascoran in Honduras, “which, along with the central plain of Comayagua, constitute a great transverse valley running north and south from sea to sea, and cutting completely through the chain of the Cordilleras. The highest point of this pass is 2850 feet above the sea, and the country around is composed of undulating savannahs and plains covered with grass.” Such a region, along with the termination of a major forest habitat, might well serve to complicate and strengthen a partial blockade to the spread southward of the forest’s trees and any *Amanita* symbionts.

8. Possible examples of Graysian distribution

This subject has been repeatedly treated in the past (e.g., Hongo and Yokoyama 1978; Yang 2000a). Yang, in particular, has listed pairs of related *Amanita* taxa with Graysian distribution, and the list that follows is a variation of his. One notable example includes the species of stirps *Hemibapha* that has a major center of distribution ranging from Pakistan and India to Siberia in the north and insular southeast Asia in the south and a lesser center of distribution in eastern North America and Central America. Some other pairs of closely phenetically related taxa with an apparent Graysian distribution are *A. abrupta* and *A. sphaerobulbosa* Hongo, *A. bisporigera* G. F. Atk. and *A. subjunquillea* var. *alba* Zhu L. Yang, *A. cokeri* and *A. ejii* Zhu L. Yang, and *A. farinosa* and *A. farinosa sensu auct. Asia orient.* Additional such pairings are *A. flavoconia* vars. and *A. flavipes*, *A. frostiana* and *A. subfrostiana*, *A. magnivolvata* Peck and *A. oberwinklerana* Zhu L. Yang and Yoshim. Doi, *A. rubescens sensu auct. USA orient.* and *A. orsonii*, and *A. westii* (Murrill) Murrill and *A. sculpta* Corner & Bas. Moreover, the following two sets of taxa could be so paired: all known (described and undescribed) species of sect. *Amidella* in the Americas (a major center of distribution for the small section) and *A. avellaneosquamosa* (S. Imai) S. Imai and *A. clarisquamosa* (S. Imai) S. Imai in E. J. Gilbert. See, also, the discussion of “*A. conara*” in the following section.

9. Possible Malayo-American and Andean Australo-antarctic elements

Only two potential ectomycorrhizal symbionts are recorded with *Amanita* in Andean Colombia—*Quercus humboldtii* and *Colombobalanus* (= *Trigonobalanus*) *excelsa* (Tulloss et al. 1992b).

The latter tree is representative of a group of Malayo-American taxa thought to have migrated from the Northern Hemisphere where they are now extinct (Van der Hammen 1989). The single species of *Amanita* occurring with *Colombobalanus* in Colombia [*A. aureomonile* Tulloss & Franco-Mol. in sect. *Phalloideae*] is possibly also classifiable as Malayo-American. *Amanita* “*conara*,” as a member of *Amanita* subsection *Gymnopodae* Bas [otherwise known from Australia, Malaya, and Japan (Corner and Bas 1962; Bas 1969; Reid 1980; Hongo 1982; Wood 1997)] and *Amanita humboldtii* Singer [with its phenetically closest related species native to New Zealand (*A. pekeoides* G. S. Ridl.) and Pakistan and northern India (*A. umbrinolutea* (Sect. *ex* Gillet) Bataille)] (Tulloss unpub. data) might be associated with the historically Andean Australo-antarctic element recognized in Colombian montane vegetation by Van der Hammen (1989). At this time, *A. humboldtii* and *A. aureomonile* are known only from Andean Colombia.

The range of “*A. conara*” beyond Costa Rica is uncertain; however, it should be noted that a species of subsection *Gymnopodae*—*A. ochrophylla* (Cooke & Masee) Cleland—was reported from *Quercus* forest in Guerrero edo., México by Guzmán (1975). Guzmán’s macroscopic description fits “*A. conara*” rather well; and his measurements for spores are similar to those of “*A. conara*” (Tulloss, Halling and Mueller unpub. data). The material Guzmán cited has not yet been revised by me, but it appears that “*A. conara*” may occur in Mexico. Just as this paper was in final draft, an apparent second undescribed species of subsection *Gymnopodae* (species CR18) was confirmed in Prov. Puntarenas, Costa Rica—further increasing the evidence for a Malayo-American component in the amanitas of that study region.

10. “Southern end of the line” in the Western Hemisphere

The observation made in this section is based on recent studies in Guyana (Simmons et al. 2002) as well as earlier studies in Amazonia (Bas 1978) and southeastern Brazil (Bas and de Meijer 1993), a summary of data on species of Chile and much of South America (Garrido and Bresinsky 1985; Garrido 1987), an extensive revision of collections from Argentina (Tulloss unpub. data), and Bas’ 1969 monograph. The data derived from these sources indicate that, with the exception of apparently imported taxa in gardens, parks, and tree plantations, the ectotrophs of South America outside Andean Colombia have a set of symbionts in *Amanita* disjunct from any of the lists of taxa in this paper’s appendices.

Many amanitas in South America from southern Brazil northward and east of the Andes are symbionts of leguminous or polygonaceous plants (Bas 1978; T. W. Henkel pers. corresp.; D. J. Lodge pers. corresp.); and a few amanitas of the region (as well as many in the continent’s southern “cone”) may not require a mycorrhizal partner. The border of the Andean Colombian region appears to be the “end of the line” for amanitas associated with *Quercus* and members of the *Pinaceae*. Taking the view from the south, although much work remains to be done, it seems few if any *Amanita* taxa of tropical South America have become symbionts of *Quercus*, of members of the *Pinaceae*, or, for that matter, of other families including species known to form mycor-

rhizae with the “northern” *Amanita* species such as the *Betulaceae*, *Ericaceae*, *Juglandaceae*, *Salicaceae*, etc. For example, Lodge et al. (*in press*) report that *Amanita* taxa mycorrhizal with *Coccoloba* in the Greater Antilles have not formed effective mycorrhiza with *Pinus*.

Note: I am pleased to be able to include the following information and hypotheses concerning *Dicymbe* groves and their symbionts offered by T. W. Henkel, a prepublication reader of this paper: “Mounting evidence suggest that the ectomycorrhizal genus *Dicymbe*, endemic to the greater Guiana Shield, is most closely related to the *Caesalpinaceae* of West Africa (e.g., *Gilbertiodendron* et al.) and not the other numerous arbuscular mycorrhizal caesalps that characterize the Neotropics. [A probable] part of the reason that the Amazonian/Guiana Shield amanitas appear totally endemic so far is that they may have speciated *in situ* and in isolation with specific caesalps of Gondwanan origin. If this is the case, they have been geographically isolated due the relictual distribution of their hosts upon which they are apparently strongly dependant. Given the affinities of *Dicymbe* at least, one might expect to find similar African amanitas associated with caesalps. However, this hasn’t proven true to date with *Boletaceae*, *Russulaceae*, *Cortinarius*, and *Inocybe* from the Guyana site—phylogenetic studies indicate long isolation of the site’s taxa from African relatives (Herendeen et al. 2003; Henkel et al. 2005). This hypothesis would help explain the across-the-board novelty of Singer’s Amazonian and our Guyanan collections.

“We need better information on the legume genus *Aldina* because it is confirmed ectomycorrhizal at Singer’s site, our site, and Moyersoen’s site in southern Venezuela, but is not closely related to *Dicymbe*. Almost all other reports of ectomycorrhizal legumes in the Neotropics (including *Swartzia*, *Hymenaea*, et al. in Central America and the Caribbean) are pure conjecture and not based on root excavations. What I think has gone on is that investigators have found ectomycorrhizal basidiomes in a forest, likely associated with nondescript nyctaginaceous or polygonaceous understory trees (e.g., *Neea*, *Pisonia*, *Coccoloba*) and have assumed that one of the invariably common legume canopy trees was the host, or, possibly have simply found saprotrophic members of otherwise ectomycorrhizal fungal groups. As a member of a group often collected without apparent ectomycorrhizal hosts, *A. grillipes* [see Table 7] is a candidate for the latter explanation.”

In comparison, members of the *Pinaceae* (*Abies*, *Cedrus*, *Keteleeria*, and *Pinus* (D. Arora pers. corresp.; Kumar et al. 1990; Tulloss et al. 2001; Tulloss unpub. data; Yang 1997; Yang, Zang and Yuan 2000) are available symbionts for *Amanita* in all of the collecting areas selected for the comparative study of Asian regions. Moreover, members of the *Fagaceae* (*Castanopsis*, *Lithocarpus*, or *Quercus*) are known to be available symbionts for *Amanita* in the Asian study regions everywhere except in Pakistan.

There is no marked “end of the line” phenomenon associated with the limits of the combined Asian regions of study. Looking westward, in *Amanita* section *Vaginatae*, at least one species known from the Pakistani and Indian regions of study is also well-known from much of Europe and western Asia—*A. umbrinolutea* (R. P. Bhatt et al. 2003; Tulloss et al. 2001; Tulloss unpub. data). Taking the view southward, many *Amanita* taxa appearing in the Asian region of study or their phenetically close relatives are mycorrhizal with members of the *Dipterocarpaceae* (e.g., *Dipterocarpus* and *Shorea*) and other subtropical and tropical trees with ranges extending well southward of the areas of study—through both peninsular and insular southeast Asia and at least

into northeastern Australia. In the latter region, at least a few taxa closely related to some from the Asian region of study are mycorrhizal with eucalypts (Arora pers. corresp.; Boedijn 1951; Corner and Bas 1962; Halling unpub. data; Smits 1994; Tulloss unpub. data; Wood 1997).

11. Possible role of deserts of northern Mexico—vicariant taxa

The northern Mexican deserts may play a role similar to that of the Atlantic Ocean in terms of evolution of new taxa. There are pairs of amanitas on the opposite sides of the Atlantic Ocean that are candidates for treatment as vicariant pairs—*A. cylindrispora* Beardslee of eastern North America and *A. gilbertii* Beauseign. of southern Europe and the Mediterranean region (H. E. Hallen unpub. data; Tulloss unpub. data); *A. basii* Guzmán & Ramírez-Guillén of central Mexico and *A. caesarea* (Scop.:Fr.) Pers. of southern Europe and the Mediterranean region (Guzmán and Ramírez-Guillén 2001; Tulloss unpub. data); and others.

Note: In my opinion, the last pair of taxa mentioned here are inadequately distinguished to justify the proposal of a new species from the information in the protologue. (Based on the protologue, Neville and Poumarat (2004) consider *A. basii* a synonym of *A. caesarea*.) The confusion is magnified by distinguishing the species with so few characters that both species are reported from both sides of the Atlantic. From my examination of material from both Mexico and Europe, I'm inclined to believe that there are indeed two taxa, that *A. basii* is a good species, and that the two species' ranges are completely separated by the intervening ocean.

There are also a striking number of pairs of extremely phenetically similar sister taxa within the Americas themselves. A notable set of such pairs are separated at present by the deserts of Northern Mexico and the absence of suitable ectomycorrhizal symbionts in wet Caribbean coastal regions of Texas and eastern Mexico—two blockades that have disappeared or been reduced during past ice ages. Some taxa that currently exist both in Mexico and in the USA do not show any noticeable morphological differences between populations north of the deserts and those south of the desert region. However, there are some very closely related pairs of taxa that may have diverged in only a few morphological characters from common ancestors

Pairs of taxa that illustrate this “limited divergence” (often in spore shape and in one obvious macroscopic character such as pigment of the basidiocarp or robustness of the stipe) are *A. flavoconia* var. *flavoconia* (north) and *A. flavoconia* var. *inquinata* (south) (Tulloss et al. 1992b); *A. pelioma* Bas (north) and *A. sp. M34* (south) (Tulloss unpub. data); and *A. arkansana* Rosen (north) and “*A. garabitoana*” Tulloss, Halling & G. M. Muell. nom. prov. (south) (Tulloss, Halling and Mueller unpub. data).

Notes on distribution of subgenera

The distributions of the two subgenera of *Amanita* are quite different. The species with amyloid spores (subgenus *Lepidella*) and the species with inamyloid spores (subgenus *Amanita*) both occur commonly in warmer climes, but the northern extremes of *Amanita* distribution belong to *Amanita* subgenus *Amanita* and, particularly, to its subordi-

nate section *Vaginatae*. As in the case of plants, taxa of alpine regions are similar to those of the subarctic; for example, *A. nivalis* Grev. (section *Vaginatae*) is well-known to be found in both subarctic and alpine habitats in Europe with dwarf *Salix*.

Table 6. Species per section studied for three studied regions in the Americas

	<i>inamyloid spores</i>	<i>amyloid spores</i>	
	<i>Amanita</i>	<i>Lepidella</i>	<i>Validae</i>
QUÉBEC	10	3	8
NJ/LI	15	27	19
CTR. MEX.	9	16	9

Partially illustrating the distribution of taxa with amyloid spores vs. those with inamyloid spores, Table 6 provides the number of known taxa for each of the sections of interest for the most species-rich study regions. Note the differences between Québec and NJ/LI in the amyloid-spored sections. As mentioned previously, taxa in central Mexico are probably undercounted.

Here are three additional examples of northern regions and their amanitas:

- Alaska, USA - Dr. G. A. Laursen (ALA) has kindly sent me all collections of *Amanita* made during his collecting with Dr. S. L. Stephenson and others in Alaskan tundra in the years 1990-1992. All 58 collections belong in subgenus *Amanita*. While final determinations of most of the material have not been made, 86% of the collections are assignable to section *Vaginatae*.
- Greenland - None of the 10 amanitas known from Greenland have amyloid spores (Knudsen and Borgen 1984; Tulloss 1994; Tulloss and Borgen 1996; Borgen and Tulloss unpub. data). Three of these species (including the two not in section *Vaginatae*) are very rare; and one (*A. muscaria* var. *muscaria*) has not been reported from Greenland since 1888 (Knudsen and Borgen 1984).
- Norway - Species with amyloid spores are concentrated in the south of the country and, somewhat farther northward, along the west-facing coast; but still make up only 7 species (9 taxa) of the up to 25 species (28 taxa) reported recently by Tulloss and Gulden (1999). Moreover, sections *Amidella* and *Lepidella* appear to be absent from the Norwegian mycota.

All six sections are known from all continents with one exception—*Amanita* section *Amidella* is still not known to be represented in South America.

Notes on spore shape variation in relation to latitude

1. Topic road map

Because of the exceptionally wide distribution of taxa of section *Vaginatae* (previous topic), the present topic begins by examining spore shape in relation to latitude in this large section. After establishing the pattern of more numerous taxa with narrow spores in temperate and subtropic regions compared to taxa occurring at lower latitudes, the

five other sections of the genus are examined revealing a similar trend in each. Comparison with a report on polypore spores, indicates that the mycorrhizal amanitas reverse the trend noted for the nonmycorrhizal group.

Fall rate of spores as reported by Ingold (1965) is reviewed in the hopes of generating some hypotheses that could lead to an explanation of the trends observed.

Several questions are then posed. Some are partially explored and hypotheses evaluated to the degree permitted by existing data. If an individual taxon has a very extended range including boreal forest, temperate regions, and subtropic latitudes, do its spores show variation in shape over this range? Given an apparent relation of the narrowest spored taxa to fire-prone, "leaky" ecosystems, is there a supportable explanation based on spore fall rate or other shape-related factor? Are there environmental pressures on boreal, alpine, and subarctic taxa that could help to explain a trend toward subglobose spores?

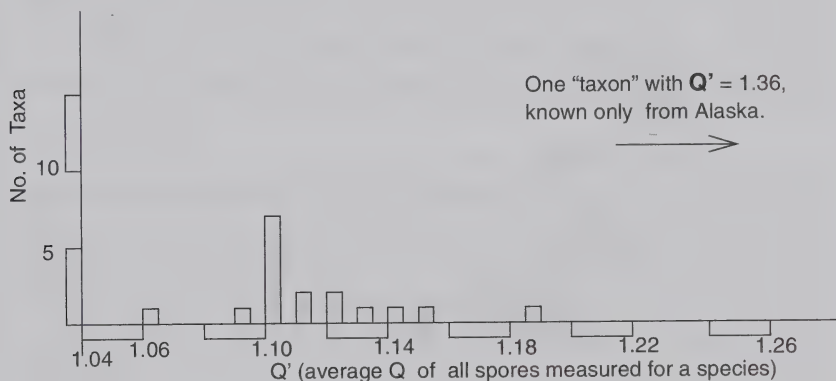


Fig. 1. Number of taxa of subarctic, alpine and boreal habitat with various values of average length/width ratio (average for all spores measured in a species) for 18 species of section *Vaginatae* for which data were available.

2. Spore shape variation in section *Vaginatae*

The range of spore shape [terminology defined by Bas (1969: 321)] is very limited in the species of the most northern latitudes. While temperate and tropical regions of the world have their species of *Amanita* with elongate (Q' between 1.60 and 2.0), cylindric (Q' between 2.0 and 3.0), or even bacilliform ($Q' > 3.0$) spores, the spores of those taxa of *Vaginatae* in the far north are dominantly (94%) subglobose (Fig. 1).

Reviewing data on section *Vaginatae* from Greenland (six taxa) and Norway (14 taxa), no entities of section *Vaginatae* were found among these with $Q' > 1.25$. In contrast, the percentage of species of *Vaginatae* with $Q' > 1.25$ is 31% in NJ/LI, 37% in Arizona and New Mexico, 38% in the Mexican region of study, and 27% in Costa Rica.

Comparing a *relatively* well-known tropical region, the number for central Africa is 65%.

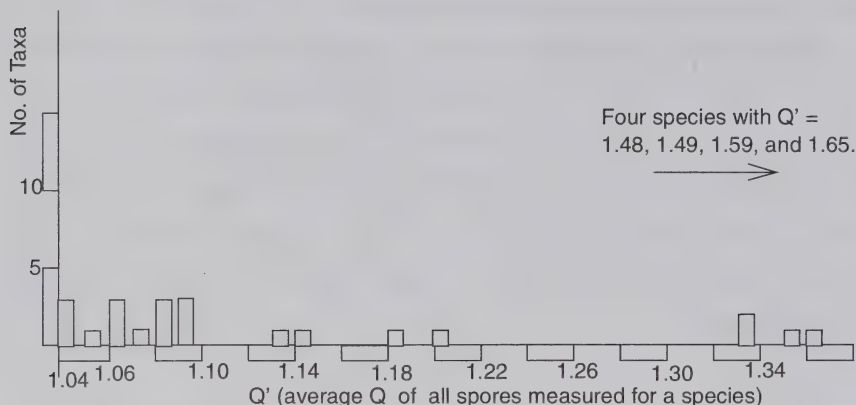


Fig. 2. Number of taxa of NJ/LI with various values of Q' for 26 species of section *Vaginatae* for which data were available.

The taxa of section *Vaginatae* known from New Jersey and Long Island and for which sufficient data is available (many are undescribed) presently number 26. The distribution of spore shape for these taxa is presented in Fig. 2. It is apparent that the shape is much more variable than in the case of the northern regions discussed above. Although there is a concentration of taxa with globose to subglobose average spores, 38% of the taxa (10) have broadly ellipsoid to ellipsoid or elongate average spores.

In comparison to the data of Fig. 2, central Africa has a minimum of 17 known taxa in section *Vaginatae*. There is evidence that this represents a significant undercounting of such taxa (Tulloss and F. V. Alofe unpub. data). Of the known taxa 35% have Q' below 1.3; 47% have ellipsoid average spores; 12%, elongate average spores; and 6%, cylindric average spores. The corresponding numbers for the NJ/LI region are 69%, 27%, 4%, and 0%.

In the case of the NJ/LI region, many of the taxa with higher Q' are annulate species; however, there are exannulate taxa in the northern temperate and subtropical zone with broadly ellipsoid to ellipsoid to elongate spores. One group of such taxa are those phenetically related to *A. mairei* Foley in the Mediterranean region (Tulloss 1994; unpub. data); another includes several taxa associated with *Coccoloba* along Caribbean coasts (e.g., *A. dunicola* Guzmán and *A. yucatanensis* Guzmán).

At least eleven probably good new species with Q' between 1.16 and 1.60 have been counted by the author in Canada, Mexico, and the USA. Worldwide, published and unpublished, at least 145 taxa fall in the same category (Tulloss unpub. data). Referring to Fig. 1, we note that *only one* of these 145 is known to occur in subarctic, alpine, or boreal environments.

There are nine taxa known from section *Vaginatae* having Q' exceeding 1.60. All but two of these are known from the eastern USA. The most elongate spores known from section *Vaginatae* belong to

- the poorly known, annulate species *A. cokeriana* Murrill (Florida, USA), with $Q' = 1.90$ (Tulloss unpub. data)
- the weakly annulate species "*A. nigeriana*" Tulloss & F. V. Alofe *nom. prov.* (Osun State, Nigeria), with $Q' = 2.09$ and a high percentage of spores falling in Bas' "cylindric" category (Tulloss & F. V. Alofe unpub. data).
- the exannulate species *A. floridana* (Murrill) Dav. T. Jenkins *ex* Tulloss *comb. nov.* (Florida, USA, see note immediately below), with $Q' = 1.86$ (Tulloss unpub. data) and *A. pallidochracea* A. E. Wood (New South Wales, Australia), with $Q' = 1.81$ (Wood 1997)

Note: Basionym: *Amanitopsis floridana* Murrill. 1949. *Mycologia* 41: 490.

≡ *Vaginata floridana* (Murrill) Murrill. 1949. *Mycologia* 41: 490.

≡ *Amanita floridana* (Murrill) Dav. T. Jenkins *comb. inval.* 1986. *Amanita* N. Amer:

66. [Lacking full and direct reference to basionym. ICBN §33.2]

Type study: Jenkins. 1979. *Mycotaxon* 10: 179. Type study: Tulloss (in prep.).

HOLOTYPE: FLAS

3. Distribution of elongate- to bacilliform-spored taxa by section

In other sections of *Amanita* that include elongate-, cylindric-, or bacilliform-spored taxa, those taxa also occur almost entirely in temperate, subtropical, or tropical regions. There are 25 taxa world-wide with elongate spores in section *Amanita*; ten of these occur in Mexico, the USA, or Canada (including one species, *A. wellsii*, with a range extending from the central Appalachians of the USA through the boreal forest to northern limits of *Alnus*). All but the single exception cited occur only in temperate or subtropical regions.

In the small section *Amidella*, nearly two-thirds of the known taxa have $Q' > 1.60$; and 90% of these taxa have their entire ranges within the temperate, subtropical, or tropical regions.

Two examples have been given above of countries with subarctic to boreal environments in which *Amanita* section *Lepidella* is apparently absent. In the northern part of the northern temperate zone, few taxa of this section occur around the world (see the taxa of the Québec region of study in this paper or the few species of section *Lepidella* among the 27 amanitas listed for Switzerland by Breitenbach and Kränzlin (1995)). Worldwide, section *Lepidella* is assigned 81 taxa with average spores elongate, cylindric, or bacilliform—about 35% of the section's total taxa worldwide (Tulloss unpub. data). The narrowest spores in the section occur in taxa from the Americas; the only five taxa in the section known to have bacilliform average spores all occur in the SE USA. Species with dominantly cylindric spores number 25 worldwide, of which six are known only from Australia; one is known only from the Mediterranean region and southern Europe; and the remainder (18) are known only from the USA (mostly from the southeastern states).

Amanita section *Phalloideae* is thought to contain less than 70 taxa worldwide at present. Of these, seven to eight have spores with Q' greater than 1.60; one is known only from Australia; and the remainder are known only from Mexico and the eastern USA (largely from southeastern states). Five to six taxa are known to have cylindric average spores, and they all fall in the group from the Americas. None have bacilliform average spores.

Amanita section *Validae* includes 124 taxa for which spore shape and size information is available. Of these, up to 13 have elongate (up to 11 taxa) or cylindric (2 taxa) average spores. None have bacilliform average spores. Both the cylindric-spored taxa are from the USA (one reported from California; one, from Alabama). The elongate-spored taxa are reported from central Africa (*A. rubescens* var. *congolensis* Beeli), Australia (two taxa described from New South Wales), and the eastern and southeastern USA (up to 8 taxa).

Apparently, there are, at the very least, fewer restraining factors for elongate to bacilliform spore shape in temperate, subtropical, and tropical regions than there are in alpine, subarctic, and boreal regions. It is important to note that the number of taxa of *Amanita* known from the New World tropics is very limited at present and, while several monographic studies exist at this writing, the only large scale, modern monographs treating amanitas are the study of section *Lepidella* by Bas (1969) and the study of *Amanita* in southwestern China by Yang (1997). Many type studies remain to be done, and, as noted above, only about half of the species of *Amanita* that may exist have been described.

4. Contrast with the situation reported for polypores

Among central African amanitas (Fig. 5, below), 17 of 44 (39%) of known taxa have elongate or cylindric average spores (Tulloss unpub. data). In the NJ/LI region of study 28 of 105 taxa (27%) have elongate, cylindric, or bacilliform average spores (Tulloss unpub. data). It is worth noting that 17 of these 28 are species of section *Lepidella* at or near the northern limit of their ranges (Tulloss unpub. data)—none of these occur in Prov. Québec and the great majority are members of the group discussed below in section 7.

The trend reported here for *Amanita* spores appears to be the reverse of the case for polypores reported by Ryvarden (1993), in which the most northern taxa studied (European and North American) had a slightly greater tendency to be cylindric to allantoid than did the tropical (East African) taxa.

5. Fall rate of spherical vs. elongated spores

In his work on spore liberation, Ingold (1965:14-15) reported studies on fall rate of ellipsoid particles carried out by a certain A. Fonda "under the aegis of the National Coal Board." Essentially, the more elongated the form of an ellipsoid particle of a given mass, the slower it falls. When random positioning of the particle is taken into account, the fall rate is slower than if it falls with the major diameter vertically oriented (i.e., any tumbling tends to slow the fall further—a phenomenon that has no effect on a

spherical particle). In *Amanita* elongate spores tend to develop with the major diameter roughly parallel to the ground and ejection occurs approximately in this position—the position that (*without tumbling*) is associated with the slowest rate of fall.

Given the above and the fact that, because of their stipe length, almost all amanitas eject their spores into turbulent air, I have assumed that *Amanita* spores tumble as they fall and almost never fall in a position with the major axis perpendicular to the ground. I have supposed that Fonda's curve of the mean terminal velocity of randomly oriented ellipsoids is most representative of the relative terminal velocity of variously shaped *Amanita* spores. The relative terminal rate of fall of spherical spores is defined as 1.0. The approximate range of relative terminal rate of fall of ellipsoid spores is 0.945 - 0.96; that of elongate spores, 0.91 - 0.945; that of cylindric spores, 0.83 - 0.91; and that of bacilliform spores has a maximum at 0.83. A few species of *Amanita* produce some spores with *Q* of 4.0 or even 5.0; such spores would have approximate relative terminal rates of fall of 0.775 and 0.72, respectively.

6. Do individual taxa with broad distribution show spore shape variation related to latitude?

Lodge (pers. corresp.) suggested exploration of spore shape related to theoretical rate of fall; also, she put forward the following question: In cases of possible vicariant taxa or of species with extended north-south ranges, is there evidence of pressure for elongation of spores in more tropical (parts of) ranges?

The answer to the latter question appears to be that there is no such evidence available from the regions of study in the Americas. Either spore shape and size do not show very much change in the cases examined (*muscaria* subsp. *flavivolvata*, *wellsii*, *xylinvolve*, *polypyramis*, *daucipes*, *flavorubens*, *pelionalspecies M34*, etc.); or there is evidence of a reverse tendency (*flavoconia* vars.).

Recent ice ages repeatedly compressed ranges of the Northern Hemisphere symbionts of *Amanita* contributing to remixing of the gene pool of the species of interest or regeneration of the northern distributional areas of these species from southern US and Mexican stocks. One might suppose that these forces served to modify any pressures for change that may have been (or are) present. The relative uniformity of symbionts over the ranges of the above species has been noted. In addition, the fact that the taxa we have listed are montane in the southern parts of their ranges while occurring at or near sea level in the northern parts suggests some requirement for stability in their environments. Hence, whatever the latitude-related effect may be, it would probably have less impact in the group of taxa with extended ranges than is observed in a diverse set of taxa with restricted ranges.

7. Relation of narrow spores to dry, fire-prone, or "leaky" ecosystems

Many species of section *Lepidella* with markedly narrow spores occur in the southeastern USA at low elevations in the coastal plains of the Atlantic Ocean and Gulf of Mexico, from Cape Cod, Massachusetts (*A. subsolitaria*) to the pine plains of eastern Texas

where there occur at least a dozen species in the group (Tulloss unpub. data). Currently existing conditions may have contributed to the development of narrow spores—for example, pressure due to frequent fire or low nutrient content of deep sandy soils in the “leaky ecosystem” (Woodwell 1979) of dry coastal plain regions. It is tempting to believe that the deeply inserted stipes and/or significantly elongated bulbs of many of the very narrow-spored species in section *Lepidella* are adaptations to the dry, low-nutrient, fire-prone environment. The common symbionts (e.g., *Pinus rigida*) of these amanitas are believed adapted to these conditions. Among the plant adaptations are dormant basal buds that are activated by loss of the major stem, subsurface table-like structures from which new sprouting can occur in similar circumstances, regeneration of leaves directly from a burned trunk, cones that open at elevated temperature during cooling immediately following a fire, staggered delay in germination of seeds, formation of mycorrhizae deep in the soil rather than near the surface, etc. (Good et al. 1979; Ledig and Little 1979; Whittaker 1979). The very narrow-spored Australian taxa cited above are species of dry eucalypt forest.

The known taxa of *Torrendia* Bres. (sequestrate amanitas) could be viewed as supporting the idea that environmental stress (in this case, again, dry and “leaky” ecosystems) can lead to spore elongation. Bas (1975) provides morphological evidence and argument supporting evolution of *T. pulchella* Bres. from a clamp-bearing ancestor in *Amanita* section *Vaginatae*. Reportedly, spores of this Mediterranean area species (known at least from Algeria, France, Morocco, Portugal, and Spain) have upper limit of length (excluding upper extreme) of 18 μm and Q' of about 2.8. A similar origin is arguably the case for the recently described *T. grandis* Bougher (1999) and *T. inculta* Bougher (1999)—with the same pair of values being (14.5 μm , 1.48) and (14 μm , 1.84), respectively (unusually, for *Amanita* studies, including the apiculus in the measurement). *Torrendia arenaria* f. *arenaria* O. K. Mill. & Horak (1992) was described from West Australia and has a reported nonextreme upper limit of spore length and Q' of 13.5 μm (including the apiculus in the measurement) and 1.51, respectively. The spores are inamyloid; the stipe is totally elongating; the basidia are reported to lack clamp connections; hence, descent from a clampless ancestor in section *Vaginatae* seems arguable for *T. arenaria*.

Note: During the final preparation of this paper, I received a copy of a poster presented by H. E. Hallen et al. (2004). The poster reports on molecular work concerning *Amanita*, *Amarrendia*, and *Torrendia*. Trees based on sequencing of ribosomal ITS and 28S rDNA are computed based on a large number of taxa in the *Amanitaceae*. There are significant differences in the placement of *Torrendia* within the two trees. The morphological arguments above are supported by the 28S tree which places *T. grandis*, *T. inculta*, and *T. pulchella* in a clade comprising taxa within the morphologically defined stirps *Hemibapha* (Tulloss 1998b) within section *Vaginatae sensu* Corner & Bas (1962). *Torrendia arenaria* is placed closest to a species of section *Lepidella* that is placed within a clade otherwise comprising taxa of section *Validae*. In the ITS tree, only *T. grandis* and *T. inculta* appear and both are placed in the clade otherwise representing section *Amanita*. This conflicts with morphological evidence: *Amanita* section *Amanita* is defined by inamyloid spores and the placement of the developing stipe tissue eccentrically (off-cen-

ter upward) in the developing “button.” All known taxa of *Torrendia* have totally elongating stipes that are centrally positioned in the “button” stage.

Note: Only four taxa in *Amanita* are known to consistently have at least 30 percent of basidia bisterigmate—these are all rather small species from eastern North America with combined ranges from the Atlantic coastal plain (discussion of ecosystem above, three of the four species present) inland to the Appalachian Mountains (Tulloss 1989; 1993) and at least as far west as the limit of distribution of eastern North American *Quercus* species.

Note: In characters of present interest, *T. arenaria* f. *lutescens* O. K. Mill. & Horak (1992) differs by having $Q' = 1.29$. The differentiating macroscopic character of the forma is yellowing of cut or abraded tissue. This latter character was discussed by Tulloss (1998, 2000b) based on North American collections of *Amanita* and considered a probable effect of an unknown “infecting” agent. Such “infected” specimens (e.g., such collections of *A. subsolitaria*) may have stunted or deformed spores.

The very narrow-spored species are the species that would have spores with the slowest fall rate according to Ingold (above). In a dry, more or less open forest, these spores would have the ability to travel farthest. In the case of the U.S. species, storms often track from the Gulf of Mexico roughly northward—relatively parallel to the similarly forested Atlantic coastal plain extending from Florida to Massachusetts. So both long distance (during storms with minimal UV from sunlight) and short distance dispersal is possible even for the relatively fragile *Amanita* spore. This could be an advantage because very hot and rapidly spreading fires are common in the habitat. An experiment examining the relative frequency of reintroduction of the narrow-spored species in their ranges along the Atlantic coast in the US (e.g., since the end of the last glaciation) could be enlightening on this point.

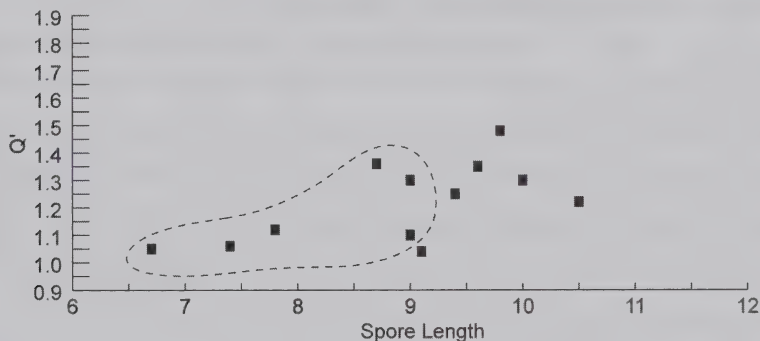


Fig. 3. A scatter plot of spore length versus Q' for the spores of species known from Brazil and Guyana. Points representing species with spore length less than or equal to 9.0 and Q' less than 1.4 have been encircled.

Another possibility is that the probable relative antiquity of section *Lepidella* has provided time for diversification in response to a complex sequence of pressures that no longer all exist, such as the stresses of major extinction events. Research since the 1960's, both morphological and molecular, has consistently indicated a basal position

for section *Lepidella* in subgenus *Lepidella* or (especially when species of subsection *Vittadiniae* are taken into account) in *Amanita* as a whole (Bas 1969; Weiss et al. 1998; Fig. 3; Drehmél et al. 1999; Hallen pers. corresp.). The geographical clustering of very narrow-spored taxa might be interpreted as indicating their ranges are relictual.

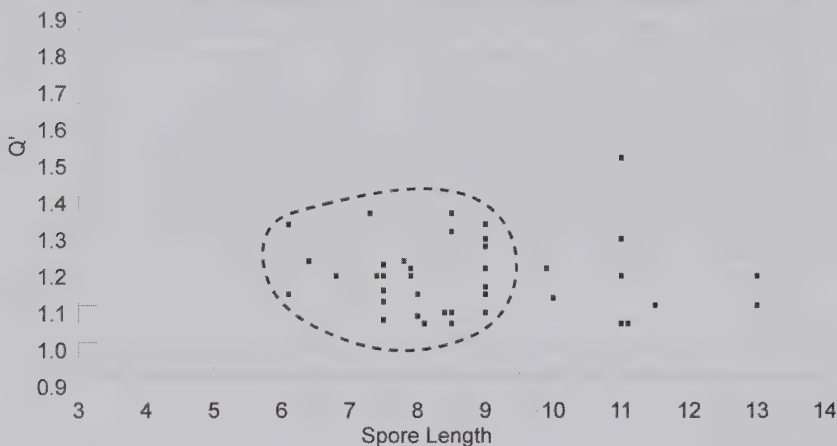


Fig. 4. A scatter plot of spore length versus Q' for the spores of species known from Singapore and Malaya. Points representing species with spore length less than or equal to 9.0 and Q' less than 1.4 have been encircled.

8. Environmental pressures on circumarctic taxa

One might also consider whether the dominance of subglobose spores in the circumarctic taxa is the result of evolutionary pressures contrasting with those of the “leaky” ecosystems discussed above.

The growing season is short in subarctic and alpine regions and the soils adaptable to plant growth may be very uniform in large areas (bogs and heaths for example). Hence, there is advantage to a short-lived spore (thin-walled, unpigmented, and thus liable to UV damage) reaching the substrate quickly. Imperfectly globose spores have somewhat greater dispersibility and, hence, add ability for a species to survive local extinction. This spore form (relative terminal rate of fall of about 0.94 to 1.0) is indicated in the data of Fig. 1.

NOTES ON SPORE SIZE REDUCTION IN THE TROPICS

1. *Amanita* spore size in lowland tropical forest

Lodge (pers. corresp.) made the suggestion that I expand this paper to include more information concerning *Amanita* spore size in lowland tropical forest.

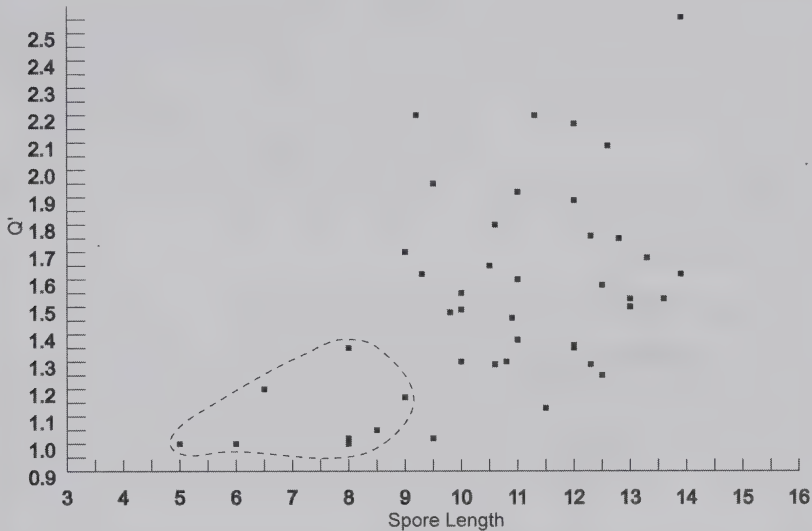


Fig. 5. A scatter plot of spore length versus Q' for the spores of species known from Central Africa. Points representing species with spore length less than or equal to 9.0 and Q' less than 1.4 have been encircled.

In the cases of some of the Asian and many of the South American tropical taxa of *Amanita*, the forest habitat is highly diverse and available symbionts are likely to be widely and irregularly separated (in contrast to the more northern forests) or, as in the case of *Dicymbe* symbionts in Guyana, forms a matrix lacking in ectotrophs in which isolated dense groups of ectotrophs occur (e.g., Henkel et al. 2002). Widely scattered dispersal of potential symbionts is true in some African forests, but this is *not* true of some of the habitats in which numerous African amanitas have been collected—such as the extensively human-modified *Uapaca* or *Brachystegia* miombo woodland over 300 m elev. that is cool in the rainy season and has plentiful available symbionts (B. Buyck pers. corresp.; Buyck 1994; Härkönen et al. 1994; Wilson 2001; Henkel et al. 2002; Alofe unpub. data). Hence, although probably far from complete, the data sets from Brazil and Guyana and Malaya and Singapore (Figs. 3 and 4) could be assumed to be more representative of highly diverse tropical forests than the African forests (Fig. 5) for which data is available.

2. The polypore case—a contrast

Besides spore shape, Ryvarden (1993) also examined polypore spore size change with relation to latitude. The ten largest-spored African polypore taxa had spores 7% to 75% larger than their correspondingly ranked species in the list of ten largest-spored European taxa.

Table 7. Taxa of tropical forest in Brazil and Guyana

Species	95th percentile spore length	High diversity forests w/ very few or isolated ectotrophs	Forests w/ low species diversity or abundant ectotrophs	Secondary forest w/ moderate no. of ectotrophs
<i>aurantiobrunnea</i> Simmons et al. (sect. <i>Phalloideae</i>)	9.4	+		
<i>calochroa</i> Simmons et al. (sect. <i>Amanita</i>)	7.8	+		
<i>campinaranae</i> Bas (sect. <i>Validae</i>)	6.7	+		
<i>coacta</i> Bas (sect. <i>Vaginatae</i>)	10.0			+
<i>craseoderma</i> Bas (sect. <i>Vaginatae</i>)	9.0	+		
<i>crebresulcata</i> Bas (sect. <i>Vaginatae</i>)	10.5			+
<i>cyanopus</i> Simmons et al. (sect. <i>Validae</i>)	8.7	+		
<i>grallipes</i> Bas & de Meijer (sect. <i>Lepidella</i> , possibly <i>not</i> ectomycorrhizal with native trees)	9.6	+		
<i>lanivolva</i> Bas (sect. <i>Amanita</i> , but having a very unusual membranous volval sac)	9.8	+		+
<i>perphaea</i> Simmons et al. (sect. <i>Validae</i>)	7.4	+		
<i>sulcatissima</i> Bas (sect. <i>Amanita</i>)	9.0		+	
<i>xerocybe</i> Bas (sect. <i>Amanita</i>)	9.0	+	+	

In *Amanita*, tropical taxa are known to include the species with the smallest recorded spore sizes (Gilbert 1940-41; Corner and Bas 1962; Bas 1978; Simmons et al. 2002). For example, 9 of 44 (20%) central African amanitas (Fig. 5) have 95% of spores 8 μ m or less long; 3 of 12 (25%) of the sufficiently known amanitas of Brazil and Guyana share the same characteristic (Fig. 3), while an additional 3 (25%) have 95% of spores with length 9 μ m or less. Of the taxa described by Corner and Bas (1962) from Singapore and Malaya (Fig. 4), 15 of 39 (38%) have 95% of spores 8 μ m or less long, when spores are measured from fresh material; and 14 (36%) additional taxa have 95% of spores 9 μ m or less long when measured from exsiccata.

3. Small spores not characteristic of northern temperate region *Amanita* species

On the other hand, *none* of 105 amanitas from the NJ/LI region of study have 95% of spores 8 μm or less long and only three (3%) have 95% of spores 9 μm or less long. Among Swiss amanitas, Breitenbach and Kränzlin (1995) list no taxa having spores with an upper length limit (exclusive of the upper extreme value presented) less than 10 μm long. Ninety European specific and infraspecific taxa are treated by Neville and Poumarat (2004). They exclude sect. *Vaginatae* and exannulate taxa in sect. *Amanita*. Among those taxa for which spore data is provided (often with small sample size), 10% have 95% of spores 9 μm long or less, but only one has 95% of spores measured falling under 9 μm —*A. erythrocephala* Neville, Poumarat & Aste (95th percentile of spore length = 8.0 μm), which the authors now consider a probable recent introduction to Europe. For spore size and shape, the trends reported for polypores appear reversed in *Amanita*:

4. Small spores not typical of Southern Hemisphere *Amanita* species

One could hypothesize that small spores are a characteristic of amanitas of the Southern Hemisphere; however, an examination of the *Amanita* lists for Australia and New Zealand casts considerable doubt on that supposition (Bas 1969; Gilbert 1940-41; Grgurinovic 1997; Miller 1992a and 1992b; Reid 1978 and 1980; Ridley 1991; Tulloss unpub. data; Tulloss et al. 1995). In Australia there are no *Amanita* taxa with the reported upper limit of spore length (excluding upper extreme) below 8.5 μm . There are eight of 86 known indigenous taxa with adequate available information (9%) that have such a limit of spore length less than or equal to 9 μm ; six of these eight values are exactly 9 μm . In New Zealand, there are *no* taxa with such a spore length limit less than 9 μm and three of 15 indigenous taxa (20%) with such a value equal to 9 μm . To go a little further afield and cast further doubt on the hypothesis, there are 18 indigenous taxa with adequate information reported from Argentina and Chile (Garrido 1987; Garrido and Bresinsky 1985; Tulloss and Horak unpub. data). Of these, there are none with reported non-extreme upper limit of spore length less than 8.3 μm ; and there are four (22%) with such upper limit less than or equal to 9 μm of which two taxa have such limit equal to 9 μm . Evidence indicates that nearly all taxa with maximum reported spore length (excluding upper extreme) under 8.3 μm occur in diverse tropical forest.

5. Hypotheses based on Ingold's report on spore liberation

Ryvarden put forward the hypothesis that the larger spores of some tropical polypores might provide a larger "reserve for germination, thus ensuring an accrued life potential in less favourable environments." Based on Ingold (1965), such spores are also more likely to strike immobile, vertically aligned cylindric objects—such as tree trunks—a valuable trait for parasitic or saprophytic fungi (see data on polypores, above).

What hypothesis could be put forward for the situation we observe in terrestrial and dominantly mycorrhizal *Amanita* taxa? It appears that small generally more globose spores may provide an advantage for species dispersal and survival. Small spore size may result in more time spent aloft due to turbulence, and small spores with low Q' have the best chance of being blown around obstacles such as tree trunks (Ingold 1965: 9-11). This would be an advantage in diverse tropical forests where appropriate symbionts may be scattered (Lodge pers. corresp.).

More habitat details are available for the South American taxa than for the Asian taxa (Bas 1978; Bas and de Meijer 1993; Simmons et al. 2002; Singer and da Silva Araujo 1979). This allows us to examine the relationship between spore length and diversity of known habitat (Table 7). In Guyana, the habitats with the highest and lowest diversity of ectomycorrhizal symbionts may occur adjacently or nearly so; and some taxa are known to occur in both habitats. First we notice that the species of sections *Vaginatae* and *Lepidella* are, as in Asia, adapted without reduction of spore length to the degree seen in taxa of other sections—especially those of sections *Amanita* and *Validae*. Of the three taxa with the relevant spore measurement less than 8.3 μm , two occur only in high diversity tropical forest with symbionts collected in segregated groves. Of the four species only known from forests with plentiful ectotrophs (excluding species of section *Vaginatae*), three have spores with the relevant measurement greater than or equal to 8.7 μm . As more is learned of the species in the table and more species are found, it will be interesting to see if these or other trends are observable in the data. There are more *Amanita* taxa to be described from Henkel's Guyana collections. While many of them are from section *Vaginatae* (Bas pers. corresp.; Henkel et al. 2002), there are still a significant number from other sections (Henkel, pers. corresp.).

The species bearing small spores tend to have spores limited in shape— $Q' < 1.3 - 1.4$ (Figs. 3-5). This could be related to the amount of material that must be packaged within the spore. To sustain this subtopic's hypothesis, we must assume that the small spore's limitation to being ellipsoid on average does not override the hypothetical advantage of small size. Why the supposed advantage of small spores is not seen more frequently in sections other than the widely morphologically and phylogenetically separated sections *Amanita* and *Validae*, also remains an open question.

6. Summary of discussion of spore size

In summary, the spore size data offers support to the hypothesis that “small-spored” species in *Amanita* (especially those with spores having the 95th percentile of length reported less than 8.3 μm) have a very high likelihood of being species of diverse tropical forest dominated at least locally by nonectomycorrhizal trees to which forests the spores may be adapted for aerial “roaming” around tree trunks. This character could increase the potential for germination near widely scattered individual symbionts or tightly grouped groves of symbionts—only available at some distance from a spore's source.

Acknowledgments

I extend my sincere gratitude to the curators of all the herbaria cited in this paper and to all the colleagues who have sent me literature, material, and observations over more than a quarter century. My greatest thanks must always go to my mentor, Cornelis Bas (L), who has freely given me information, guidance, and highly valued friendship for two decades: Thank you, dear friend! Once again, I extend my gratitude to Zhu L. Yang (Kunming Institute of Botany, Academia Sinica, Yunnan, China) who reviewed this paper for publication making several useful suggestions and helping me understand the limits of the "southwestern China" region; for over a decade, he has generously shared material, literature, and his expertise in *Amanita* with me. I am particularly grateful to C. L. Ovrebø (CSU) who reviewed this paper for publication and has loaned me many collections from Colombia, Costa Rica, and Panama and whose invitation to speak at the 2002 meeting of the Assoc. Micol. Latinoamericana in Xalapa, provided the spur to my compiling this paper based on (Tulloss 2002); to D. J. Lodge (U. S. Dept. Agric.-Forest Service, Forest Products Lab., Luquillo, Puerto Rico) who encouraged my work on this paper, discussed its contents with me, reviewed it for publication, and provided publications, observations, and questions triggering significant extension of the paper's content; and to R. E. Halling (NY) who encouraged my work on this paper, provided numerous publications describing Central American and Colombian forests and their history, provided me the hospitality of his laboratory facilities, and, along with Ovrebø, gave me the opportunity to revise the amanitas of Andean Colombia, provided the opportunity to collect in Costa Rica, and, with G. M. Mueller (F), is collaborating with me on revision of the amanitas of the latter country. Two other pre-publication readers of this paper contributed to my understanding of tropical forests and their mycorrhizal symbionts and made valuable suggestions that have improved the paper—T. W. Henkel (Humboldt St. Univ., Calif.) and E. Horák (ZT), and I am grateful for their support. In addition, I express my gratitude to A. E. Franco-Molano (COL) who has continued to send material from Colombia and Costa Rica to NY for more years than I care to think about while patiently waiting for me to finish joint work on an update on Colombian amanitas; to F. H. Nishida (Topanga, Calif., USA) who invited me to participate in the Chiricahua Mycoflora Project and revise the amanitas of the "sky island" mountains of southeastern Arizona and arranged for me to meet several Mexican colleagues; to V. M. Bandala (XAL), J. Cifuentes (ENCB), A. Estrada-Torres (TLXM), G. Guzmán (XAL), L. Guzmán-Dávalos (IBUG), T. Herrera (MEXU), A. Kong-Luz (TLXM), L. Montoya (XAL), A. Montoya-Esquivel (TLXM), E. Pérez-Silva (MEXU), and M. Villegas-Ríos (ENCB) and their students and others who have been my hosts in Mexico at one time or another, shared Mexican literature with me generously, provided valued discussions, and supported my all-too-brief trips collecting *Amanita* in Mexico; to my co-authors of the study of Pakistani amanitas (Tulloss et al. 2001) and the recent checklist of Indian *Amanitaceae* (R. P. Bhatt et al. 2003) and others—H. R. Bhandary (Brampton, Ontario, Canada), R. P. Bhatt (GUH), V. K. Bhatt (Res. Fndn. Sci. Technol. Ecol., Dehradun, India), R. Boehne (San Rafael, Calif., USA), S. H. Iqbal (LAH), A. N. Khalid (LAH), A. Kumar (H.P. Krishi Vishva Vidyalyaya Oilseeds Res. Stn., Kangra, India), T. N. Lakhnpal (HPUB), J.-M. Moncalvo (Ctr. Biodiv. Conservation Biol., Roy. Ontario Mus. Dept. Bot., Univ. Toronto, Canada), K. Nazir (Pakistan Mus. Natural Hist., Islamabad), K. C. Semwal (Nat. Res. Ctre. Mushr., Chambaaghat, Solan, Himachal Pradesh, India), S. L. Stephenson (Univ. Arkansas, Fayetteville, USA), K. B. Vrinda (Microbiol. Div., Tropical Bot. Gard. & Res. Inst., Palode, Thiruvananthapuram, Kerala, India)—who have supplied me with material, photographs, and literature from India and Pakistan for many years; to Fola V. Alofe, Obafemi Awolowo Univ., Ife-Ife, Osun State, Nigeria, for her initiative and cooperation in jointly preparing descriptions for unusual novel taxa from her country; to David Arora (Mendocino, Calif., USA) for correspondence, discussion, and photographs and exsiccata sent from within, and to the south of, the Chinese region of study as well as

plentiful collections and photographs from central Africa; to T. Borgen (C) for extended correspondence and numerous gifts of literature and material from Greenland; to B. Buyck (PC) for his generous hospitality while hosting me at his institution, for loans of African material, and for his advice on the habitats of African taxa of *Amanita*; to Neale L. Bougher (PERTH) for sending recent off-prints; to E. Horak for loan of materials from Chile and Argentina and translation of field notes from German to English; to G. A. Laursen (ALA) for extended loan of collections from Alaska; to J. E. Wright (BAFC) for generous loan of the entire set of *Amanita* collections from his institution; to David C. Tulloss (Lambertville, New Jersey, USA) for the design and development of web pages and functional software of the tripartite similarity calculator and biogeographic affinity calculation; and to Mrs. Mary A. Tulloss, Miss Lindsay Possiel, and Miss Molly Marko (all of Roosevelt, New Jersey, USA) for assisting me with preparation of this paper for publication. For collecting expeditions in Mexico, I am grateful for the support of colleagues named above, the N. American Mycol. Assoc.; Soc. Mexicana Micol.; Fac. Ciencias, Univ. Autón. Edo. México; Fac. Ciencias, Univ. Autón. Nac. México; and Lab. Micol., Univ. Autón. Tlaxcala. For a collecting expedition in Costa Rica, I am grateful to the New York Bot. Gard. for support from a National Science Foundation grant.

Literature cited

- Bas, C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. *Persoonia* 5(4): 285-579.
- Bas, C. 1975. A comparison of *Torrendia* (Gasteromycetes) with *Amanita* (Agaricales). *Nova Hedwigia* 51: 53-60.
- Bas, C. 1978. Studies in *Amanita*—I. Some species from Amazonia. *Persoonia* 10: 1-22.
- Bas, C. 1982. Studies in *Amanita*—II. *Persoonia* 11(4): 429-442.
- Bas, C. 2000. Una visione più ampia sulle *Amanita*. *Boll. Gruppo G. Bresadola* 43(2): 9-12.
- Bas, C. and A. A. R. de Meijer. 1993. *Amanita grillipes*, a new species in *Amanita* subsection *Vittadiniae* from southern Brazil. *Persoonia* 15: 345-350.
- Bas, C. and S.-I. Hatanaka. 1984. An undescribed species of *Amanita* section *Lepidella* from Japan. *Persoonia* 12: 321-325.
- Beeli, M. 1935. Flore iconographique des champignons du Congo. (J. Lebègue, Brussels). 27 pp., 4 pl.
- Belt, T. 1874. The naturalist in Nicaragua. [1888 ed., reprinted in facsimile 1985 by Univ. Chicago Pr.]. xxxvi+403 pp.
- Bhatt, R. P., R. E. Tulloss, K. C. Semwal, V. K. Bhatt, J.-M. Moncalvo and S. L. Stephenson. 2003. *Amanitaceae* from India. A critically annotated checklist. *Mycotaxon* 88: 249-270.
- Bhatt, V. K., R. P. Bhatt, R. D. Gaur, and M. P. Singh. 1999. Mushrooms of Garhwal Himalaya: the genus *Amanita* Pers. ex Hooker. *Mushr. Res.* 8: 1-8.
- Boedijn, K. B. 1951. Notes on Indonesian fungi. The genus *Amanita*. *Sydowia* 5(3-6): 317-327.
- Bougher, N. L. 1999. New species of *Torrendia* (Fungi, Agaricales) from remnant woodlands in the Wheatbelt region of Western Australia. *Austral. Sys. Bot.* 12: 145-156.
- Breitenbach, J. and F. Kränzlin. 1995. Fungi of Switzerland 4: 1-368.
- Buyck, B. 1994. Ubwoba: Les champignons comestibles de l'ouest du Burundi. (Admin. Gén. Cooperation au Developpement, Bruxelles). [ii]+123 pp.
- Chen, Z.-H., Z.-L. Yang and Z.-G. Zhang. 2001. Three noteworthy *Amanitae* of subgenus *Lepidella* from China. *Mycotaxon* 79: 275-284.
- Cifuentes Blanco, J. 1996. Estudio taxonomico de los generos hidnoides estipitados (Fungi: Aphyllphorales) en México. doctoral thesis (Univ. Nac. Autón. México). [viii]+289 pp.

- Corner, E. J. H. and C. Bas. 1962. The genus *Amanita* in Singapore and Malaya. *Persoonia* 2: 241-304.
- Deprés, J., Y. Lamoureux, R. Boyer, R. Archambault and A. Jean. 2002. Mille et un champignons du Québec. (Cercle Mycologues Montréal). compact disc.
- Drehmel, D., J.-M. Moncalvo and R. Vilgalys. 1999. Molecular phylogeny of *Amanita* based on large-subunit ribosomal DNA sequences: Implications for taxonomy and character evolution. *Mycologia* 91: 610-618.
- Elmore, F. H. 1976. Shrubs and trees of the southwest uplands. (SW Pks. Monuments Assoc., Tucson). [ii]+214 pp.
- Estrada-Torres, A. 1994. La familia *Gomphaceae* (Aphylllophorales, Fungi) en el estado de Tlaxcala. doctoral thesis (Int. Politéc. Nac., Escuela Nac. Ciencias Biológ.). [vi]+186 pp., 12 pl.
- Farrand, J., ed. 1983. The Audubon Society master guide to birding. (Knopf, New York) 2. 398 pp.
- Garrido, N. 1987. Agaricales s.l. und ihre Mikorrhizen in den Nothofagus-Wäldern mittelchiles. doctoral dissertation Regensburg Univ. 512 pp.
- Garrido, N. and A. Bresinsky. 1985. *Amanita merxmuelleri* (Agaricales), eine neue Art aus *Nothofagus*-Wäldern Chiles. *Bot. Jahrb. Syst.* 107: 521-540.
- Gilbert, E. J. 1940-41. *Amanitaceae*. *Iconogr. Mycol.* (Milan) 27, suppl. 1(1-3): i-xx, 1-427, pl.
- Gilbert, E. J. 1941. Notules sur les amanites. (Libraire E. Le François, Paris). 23 pp. + 1 pl.
- Good, R. E., N. F. Good and J. W. Andresen. 1979. The pine barren plains *In*: Forman, R. T. T., ed. *Pine barrens: Ecosystem and landscape*. (Academic Pr., New York): 283-295.
- Grgurinovic, C. A. 1997. Larger fungi of South Australia. (Bot. Gard. Adelaide St. Herb., Fl. Fauna S. Austral. Handb. Comm.). vi+725 pp.
- Guzmán, G. 1975. New and interesting species of Agaricales from Mexico *In*: H. E. Bigelow and H. D. Thiers, eds. *Studies on Higher Fungi*. *Beih. Nova Hedwigia* 51: 99-118, pl. 24-30.
- Guzmán, G. and F. Ramírez-Guillén. 2001. The *Amanita caesarea*-complex. *Biblioth. Mycol.* 187: i-vii, 1-66.
- Hallen, H. E., N. L. Bougher and T. Lebel. 2004. Phylogenetic placement of *Amarrendia* and *Torrendia*: sequestrate *Amanita*—or a mixed bag? 2005 Mycol. Soc. Amer. Annual Mtg., 17-21 July. poster. [Abstract: *Inoculum* 55(4): 15.]
- Halling, R. E. 2001. Ectomycorrhizae: Co-evolution, significance, and biogeography. *Ann. Missouri Bot. Gard.* 88(1): 5-13.
- Härkönen, M., T. Saarimäki, and L. Mwasumbi. 1994. Tanzanian mushrooms and their uses 4. Some reddish edible and poisonous *Amanita* species. *Karstenia* 34: 47-60.
- Hayek, L. C. 1994. Analysis of amphibian biodiversity data. *In*: Heyer, W. R. et al., eds. *Measuring and monitoring biological diversity. Standard methods for amphibians*. (Smithsonian Inst., Washington): 207-269.
- Heim, R. 1936. Aperçu sur les champignons toxiques et comestibles des Colonies françaises *In*: Curasson, G. *Pathol. Exotique Vétérin. Comparée* 3: 1-31.
- Heim, R. 1940. Une amanite moretelle de l'Afrique tropicale. *Rev. Mycol.* 5: 22-28.
- Henkel, T. W. 2003. Monodominance in the ectomycorrhizal *Dicymbe corymbosa* (*Caesalpinaceae*) from Guyana. *J. Trop. Ecol.* 19(4): 417-437.
- Henkel, T. W., J. Terborgh and R. J. Vilgalys. 2002. Ectomycorrhizal fungi and their leguminous hosts in the Pakaraima Mountains of Guyana. *Mycol. Res.* 106: 515-531.
- Henkel, T. W., J. Major and L. Woolley. 2005. Mast fruiting and seedling survival of the ectomycorrhizal, monodominant *Dicymbe corymbosa* (*Caesalpinaceae*) in Guyana. *New Phytol.* 167(1): *in press*, for July, 2005.

- Herendeen, P. S., A. Bruneau and G. P. Lewis. 2003. Phylogenetic relationships in caesalpinoid legumes: preliminary analyses based on morphological and molecular data. *In*: Klitgaard, B. B. and A. Bruneau, eds. *Advances in legume systematics*, part 10, higher level systematics. (Kew, Roy. Bot. Gard.): 37-62.
- Herrera Fonseca, M. de J. and L. Guzmán-Dávalos. 2002. Registro de *Amanita roseitincta* (Agaricales, *Amanitaceae*) para México *In*: Guzmán, G. and G. Mata, eds., *Estudios sobre los hongos latinoamericanos*. Proc. Assoc. Latinoamer. Mycol. 9: 221.
- Holmgren, P. K., N. H. Holmgren and L. C. Barnett. 1990. Index herbariorum. Part I. The herbaria of the world, 8th ed. *Regnum Veg.* 120: 1-693.
- Hongo, T. 1953. Larger fungi of the provinces of Omi and Yamashiro 4. *J. Japan. Bot.* 28: 69-75.
- Hongo, T. 1957. Notes on Japanese larger fungi 10. *J. Japan. Bot.* 32: 141-146.
- Hongo, T. 1959. The Agaricales of Japan I—(1). *Mem. Shiga Univ.* 9: 47-94.
- Hongo, T. 1961. On some agarics of Japan 4. *Mem. Facul. Lib. Arts Educ., Shiga Univ.* 11: 39-42.
- Hongo, T. 1967. *Notulae Mycologicae* (6). *Mem. Shiga Univ.* 17: 89-95.
- Hongo, T. 1969. Notes on Japanese larger fungi (20). *J. Japan. Bot.* 44(8): 230-238.
- Hongo, T. 1970. *Notulae Mycologicae* (9). *Mem. Shiga Univ.* 20: 49-54.
- Hongo, T. 1971. *Notulae Mycologicae* (10). *Mem. Shiga Univ.* 21: 62-68.
- Hongo, T. 1974a. Two new species of *Amanita* from *Castanopsis* forests in Japan. *In*: *Travaux mycologiques dédiés à R. Kühner*. *Bull. Soc. Linn. Lyon*: 189-193.
- Hongo, T. 1974b. *Notulae mycologicae* (13). *Mem. Shiga Univ.* 24: 44-51.
- Hongo, T. 1975. *Notulae mycologicae* (14). *Mem. Shiga Univ.* 25: 56-63.
- Hongo, T. 1977. *Notulae mycologicae* (15). *Mem. Shiga Univ.* 27: 20-25.
- Hongo, T. 1978. Materials for the fungus flora of Japan (28). *Trans Mycol. Soc. Japan* 19: 455-456.
- Hongo, T. 1982. The amanitas of Japan. *Acta Phytotax. Geobot.* 33: 116-126.
- Hongo, T. 1983. *Notulae mycologicae* (18). *Mem. Facul. Educ., Shiga Univ., Nat. Sci.* 33: 37-41.
- Hongo, T. and K. Yokoyama. 1978. Mycofloristic ties of Japan to the continents. *Mem. Shiga Univ.* 28: 76-80.
- Imai, S. 1933. Studies on the *Agaricaceae* of Japan I. Volvate agarics in Hokkaido. *Bot. Mag. Tokyo.* 47: 423-32.
- Imai, S. 1938. Studies in the *Agaricaceae* of Hokkaido. I. *J. Facul. Agri. Hokkaido Imper. Univ.* 43: 1-31.
- Imai, S. 1939. *Studia agaricacearum Japonicarum*. I. *Bot. Mag. Tokyo* 53: 392-399.
- Imazeki, R. and T. Hongo. 1957. Coloured illustrations of fungi of Japan. Osaka. 1: viii+181 pp. [In Japanese.]
- Imazeki, R. and T. Hongo. 1965. Coloured illustrations of fungi of Japan. Osaka. 2: x+239 pp. [In Japanese.]
- Imazeki, R. and T. Hongo. 1987. Colored illustrations of mushrooms of Japan 1. (Hoikusha, Osaka). viii+325 pp., 72 pl. [In Japanese.]
- Imazeki, R., Y. Otani and T. Hongo. 1988. *Fungi of Japan*. (Yama-Kei, Tokyo). 624 pp. [In Japanese.]
- Imazeki, R. and S. Toki. 1955. Contribution to the knowledge of Japanese Agaricales (I). *Bull. Gov. Forest. Exp. Sta.* 79: 1-14.
- Ingold, C. T. 1965. *Spore liberation*. (Clarendon Press, Oxford). x+210 pp.
- Jenkins, D. T. 1977. A taxonomic and nomenclatural study of the genus *Amanita* section *Amanita* for North America. *Biblioth. Mycol.* 57: 1-126.
- Kappelle, M. 1995. Ecology of mature and recovering Talamancan montane *Quercus* forests, Costa Rica. doctoral dissertation Univ. Amsterdam. 273 pp.

- Kirk, P. M. and A. E. Ansell. 1992. Authors of fungal names. Index Fungi Suppl.: [i-viii], 1-95.
- Knudsen, H. and T. Borgen. 1984. *Agaricaceae, Amanitaceae, Boletaceae, Gomphidiaceae, Paxillaceae* and *Pluteaceae* in Greenland In: G. A. Laursen, J. F. Ammirati and S. A. Redhead, eds. Arctic and Alpine Mycology II: 235-253.
- Kumar, A., R. P. Bhatt and T. N. Lakhanpal. 1990. The *Amanitaceae* of India. (Bishen Singh Mahendra Pal Singh, Dehra Dun). x+160 pp.
- Lamoureux, Y. 1999. L'Herbier de macromycètes du cercle des mycologues de Montréal. Liste des espèces herborisées. (Cercle Mycol. Montréal). [vi]+71+[xiv] pp.
- Ledig, F. T. and S. Little. 1979. Pitch pine (*Pinus rigida* Mill.): Ecology, physiology, and genetics In: Forman, R. T. T., ed. Pine barrens: Ecosystem and landscape. (Academic Pr., New York): 347-371.
- Lodge, D. J., O. K. Miller, Jr., T. J. Baroni and R. E. Halling. *in press*. Emerging biogeographic patterns among macrobasidiomycete fungi in the Greater Antilles In: Zanoni, T., ed. Biogeography of plants in the Greater Antilles. (New York Bot. Gard.)
- Miller, H. and S. Lamb. 1985. Oaks of North America. (Naturegraph, Happy Camp, Calif.). i-viii+9-327 pp.
- Miller, O. K., Jr. 1992a ["1991"]. New species of *Amanita* from Western Australia. Canad. J. Bot. 69: 2692-2703.
- Miller, O. K., Jr. 1992b. Three new species of *Amanita* from Western Australia. Mycologia 84(5): 679-686.
- Miller, O. K., Jr. and E. Horak. 1992. Observations on the genus *Torrendia* and a new species from Australia. Mycologia 84: 64-71.
- Morales-Torres, E., M. Villegas, J. Cifuentes and R. E. Tulloss. 1999. Revision of *Amanita alexandri* and its similarity to *Amanita polypyramis*. Mycotaxon 73: 477-491.
- Nagasawa, E. and T. Hongo. 1985. Some agarics from the San-in District, Japan. Mem. Nat. Sci. Mus., Tokyo 18: 73-88.
- Nagasawa, E. and S. Mitani. 2000. A new species of *Amanita* section *Lepidella* from Japan. Mem. Nat. Sci. Mus., Tokyo 32: 93-97.
- Neville, P. and S. Poumarat. 2004. *Amaniteae: Amanita, Limacella, Torrendia*. Fung. Europeae 9: 1-1120.
- Oda, T., C. Tanaka and M. Tsuda. 2000. *Amanita sinensis*, new to Japan and Nepal. Mycoscience 41: 403-405.
- Oda, T., C. Tanaka and M. Tsuda. 2001. *Amanita imazekii*—a new species in *Amanita* section *Caesareae*. Mycologia 93: 1231-1234.
- Pegler, D. N. 1978. *A preliminary agaric flora of east Africa*. Kew Bulletin Additional Series VI. 615 pp.
- Pegler, D. N. and D. Shah-Smith. 1997. The genus *Amanita* (*Amanitaceae*, Agaricales) in Zambia. Mycotaxon 61: 389-417.
- Perry, J. P., Jr. 1991. The pines of Mexico and Central America. (Timber Pr., Portland, OR). 231 pp.
- Pomerleau, R. 1980. Flore des champignons au Québec. (Les Editions La Presse, Montréal). xvi+653 pp.
- Reid, D. A. 1978. New species of *Amanita* (fungi) from Australia. Victorian Naturalist 95: 47-49.
- Reid, D. A. 1980. A monograph of the Australian species of *Amanita* Persoon *ex* Hooker (Fungi). Austral. J. Bot. Suppl. Ser 8: 1-96.
- Ridley, G. S. 1991. The New Zealand species of *Amanita* (Fungi: Agaricales). Aust. Sys. Bot. 4: 325-354.

- Ryvarden, L. 1993. Tropical polypores *In*: S. Isaac, J. C. Frankland, R. Watling and A. J. S. Whalley, eds. Aspects of tropical mycology. (Cambridge Univ. Press): 149-170.
- Simmons, C., T. Henkel and C. Bas. 2002. The genus *Amanita* in the Pakaraima Mountains of Guyana. *Persoonia* 17(4): 563-582.
- Singer, R. and I. de J. da Silva Araujo. 1979. Litter decomposition and ectomycorrhiza in Amazonian forests. *Acta Amazonica* 9(1): 25-41.
- Smits, W. T. M. 1994. *Dipterocarpaceae*: Mycorrhizae and regeneration (thesis). Tropenbos Ser. 9: 1-243.
- Tulloss, R. E. 1989. *Amanita ristichii*: a new species from New England with basidia dominantly 2-spored. *Mycotaxon* 35: 363-369.
- Tulloss, R. E. 1993. *Amanita pachysperma*, *Amanita subvirginiana*, and *Amanita virginiana* (taxonomy and distribution) with notes on the description of lamella trama in *Amanita*. *Mycotaxon* 49: 449-475.
- Tulloss, R. E. 1994. Type studies in *Amanita* section *Vaginatae* I: Some taxa described in this Century (studies 1-23) with notes on description of spores and refractive hyphae in *Amanita*. *Mycotaxon* 52: 305-396.
- Tulloss, R. E. 1997. Assessment of similarity indices for undesirable properties and a new tripartite similarity index based on cost functions. *In*: Mycology in Sustainable Development: Expanding Concepts, Vanishing Borders. M. E. Palm and I. H. Chapela, eds. (Parkway Publishers, Boone, North Carolina): 122-143.
- Tulloss, R. E. 1998a. Syllabus for a seminar on *Amanita*, 4th ed. (N. Amer. Mycol. Assoc. & Mycol. Soc. San Francisco). vi+184 pp.
- Tulloss, R. E. 1998b. ["1997"]. Provisional World Key to Species Closely Related to *Amanita hemibapha* with notes on the "Slender Caesar's Mushrooms" of Eastern North America. *McIlvainea* 13(1): 46-53. [Current, revised version available at < <http://pluto.njcc.com/~ret/amanita/key.dir/hemibkey.pdf> >
- Tulloss, R. E. 2000a. Le *Amanita* nel mondo: bellezza, pericolo e diversità. *Boll. Gruppo Micol. G. Bresadola* 43(2): 13-21.
- Tulloss, R. E. 2000b. Note sulla metodologia per lo studio del genere *Amanita* (Agaricales). *Boll. Gruppo Micol. G. Bresadola* 43(2): 41-58.
- Tulloss, R. E. 2002. *Amanita*—studies on distribution of a taxa-rich genus in the Americas *In*: Guzmán, G. and G. Mata, eds., Estudios sobre los hongos latinoamericanos. Resum. Congr. Latinoamer. Micol. 9: 52.
- Tulloss, R. E. and H. R. Bhandary. 1992. *Amanita chepangiana*—a new species from Nepal. *Mycotaxon* 43: 25-31.
- Tulloss, R. E. and T. Borgen. 1996. *Amanita mortenii*—a correction. Emendation was inappropriate. *Mycotaxon* 59: 419-425.
- Tulloss, R. E. and G. Gulden. 1999. Fluesopper i Norge. *Blekksoppen* 27(79): 3-12.
- Tulloss, R. E., T. Hongo and H. R. Bhandary. 1992a. *Amanita neoovoidea*—taxonomy and distribution. *Mycotaxon* 44: 235-242.
- Tulloss, R. E., S. H. Iqbal, A. N. Khalid, R. P. Bhatt and V. K. Bhatt. 2001. Studies in *Amanita* (*Amanitaceae*) from southern Asia. I. Some species of Pakistan's Northwest Frontier Province. *Mycotaxon* 77: 455-490.
- Tulloss, R. E. and J. E. Lindgren. 1992. *Amanita smithiana*—taxonomy, distribution, and poisonings. *Mycotaxon* 45: 373-387.
- Tulloss, R. E. and J. E. Lindgren. 1994. *Amanita novinupta*—a rubescent, white species from the western United States and southwestern Canada. *Mycotaxon* 51: 179-190.

- Tulloss, R. E., C. L. Ovrebo and R. E. Halling. 1992b. Studies on *Amanita* (Agaricales) from Andean Colombia. Mem. New York Bot. Gard. 66: 1-46.
- Tulloss, R. E. and D. C. Tulloss. 2004a. Tripartite Similarity Calculator. www.amanitabear.com/similarity/. (accessed 11 August. 2004).
- Tulloss, R. E. and D. C. Tulloss. 2004b. An on-line tripartite similarity calculator. Inoculum Feb., 2004: 1-4.
- Tulloss, R. E., A. M. Young and A. E. Wood. 1995. *Amanita murinoflammeum*—a new species from dry forests of eastern Australia. Mycotaxon 56: 295-302.
- Van der Hammen, T. 1989. History of the montane forests of the northern Andes. Pl. Syst. Evol. 162: 109-114.
- Walley, R. 1996. Notes on *Amanitopsis pudica* Beeli. Bull. Jard. Bot. Belg. 65: 215-218.
- Walley, R. and A. Verbeken. 1998a. Notes on the genus *Amanita* in Sub-Saharan Africa. Bull. Jard. Bot. Belg. 65: 215-218.
- Walley, R. and A. Verbeken. 1998b. Notes on the genus *Amanita* in Sub-Saharan Africa. Belgian J. Bot. 131(2): 156-161.
- Weiss, M., Z.-L. Yang, and F. Oberwinkler. 1998. Molecular phylogenetic studies in the genus *Amanita*. Canad. J. Bot. 76: 1170-1179.
- Whittaker, R. H. 1979. Vegetational relationships of the Pine Barrens. In: Forman, R. T. T., ed. Pine barrens: Ecosystem and landscape. (Academic Pr., New York): 315-331.
- Wilson, A. 2001. Miombo! Living Planet Summer 2001: 70-79.
- Wood, A. E. 1997. Studies in the genus *Amanita* (Agaricales) in Australia. Austral. Syst. Bot. 10: 723-854.
- Woodwell, G. M. 1979. Leaky ecosystems: Nutrient fluxes and succession in the Pine Barrens vegetation. In: Forman, R. T. T., ed. Pine Barrens: Ecosystem and landscape. (Academic Pr., New York): 333-343.
- Yang, Z. L. 1994. Studies of the genus *Amanita* from southwestern China (I). Mycotaxon 51: 459-470.
- Yang, Z. L. 1997. Die *Amanita*-Arten von Südwestchina. Biblioth. Mycol. 170: i-ii, 1-240.
- Yang, Z. L. 2000a. Species diversity of the genus *Amanita* (Basidiomycetes) in China. Acta Bot. Yunnanica 22(2): 135-142.
- Yang, Z. L. 2000b. Revision of the Chinese *Amanita* collections deposited in BPI and CUP. Mycotaxon 75: 117-130.
- Yang, Z. L. 2001. *Amanita pallidocarnea*, a species of *Amanita* section *Vaginatae* with pink lamellae from southeast Asia. Mycotaxon 80: 281-284.
- Yang, Z. L. 2002a. *Amanita eijii* -- a new name for *Amanita cokeri* f. *roseotincta*. J. Jilin Agric. Univ. 24(2): 32-34.
- Yang, Z. L. 2002b. Revision of *Amanita* collections from Jilin Province, northeastern China. Mycotaxon 80: 67-76.
- Yang, Z. L. and C. M. Chen. 2003. *Amanita yenii*, a new species of *Amanita* section *Lepidella*. Mycotaxon 88: 455-462.
- Yang, Z. L. and Y. Doi. 1999. A contribution to the knowledge of *Amanita* (*Amanitaceae*, Agaricales) in Japan. Bull. Natl. Sci. Mus. Tokyo B 25(3): 108-130.
- Yang, Z. L., M. Zang and M. Yuan. 2000. Distribution, ectomycorrhizal association and diversity of *Amanitae* in southwestern China. Proc. ACIR Internat. Workshop Mycorrhizae, Guangzhou 1998: 29-38.
- Yang, Z. L. and L. F. Zhang. 2002. Revisions of collections of *Amanita* (Agaricales) from Hunan Province, central China. Acta Bot. Yunnanica 24(6): 715-722.

Zhang, L. F., J. B. Yang, and Z. L. Yang. 2004. Molecular phylogeny of eastern Asian species of *Amanita* (Agaricales, Basidiomycota): taxonomic and biogeographic implications. *Fung. Diversity* 17: 219-238.

APPENDICES

Appendix Table 1. *Amanita* section *Amanita*—American regions of interest

Species	Québec	NJ/LI	AZ	Ctr. Méx.	CR	Col.
1. <i>albocreata</i> G. F. Atk.	1. +	1. +				
2. <i>crenulata</i> Peck	2. +	2. +				
3. <i>farinosa</i> Schwein.	3. +	3. +		1. +	1. +	
4. <i>frostiana</i> (Peck) Sacc.	4. +	4. +				
5. <i>guzmanii</i> Cifuentes, Villegas & Santiago				2. +		
6. <i>multisquamosa</i> Peck	5. +	5. +				
7. <i>muscaria</i> subsp. <i>flavivolvata</i> Singer			1. +	3. +	2. +	1. +i
8. <i>muscaria</i> var. <i>guessowii</i> Veselý	6. +	6. +				
9. <i>muscaria</i> var. <i>persicina</i> Dav. T. Jenkins		7. +				
10. <i>parcivolvata</i> (Peck) E. J. Gilbert		8. +				
11. <i>roseitincta</i> (Murrill) Murrill		9. +		4. +		
12. <i>russuloides</i> (Peck) Sacc.	7. +	10. +				
13. <i>velatipes</i> G. F. Atk.	8. +	11. +				
14. <i>wellsii</i> (Murrill) Sacc.	9. +	12. +				
15. <i>xylinivola</i> Tulloss, Ovrebo & Halling			2. +	5. +	3. +	2. +
16. sp. 32	10. +	13. +				
17. sp. 34		14. +				
18. sp. AZ7			3. +			
19. sp. AZ16			4. +			
20. sp. HON2					4. +	
21. sp. HON9					5. +	
22. sp. M17				6. +		
23. sp. M20				7. +		
24. sp. M21				8. +		
25. sp. M22				9. +		
26. sp. S1		15. +				

Appendix Table 2. *Amanita* section *Validae*—American regions of interest

Species	Québec	NJ/LI	AZ	Ctr. Méz.	CR	Col.
1. " <i>antioquiensis</i> " Tulloss & Franco-Molano nom. prov.						1. +
2. <i>brunneolocularis</i> Tulloss, Ovrebo & Halling					1.+	2. +
3. <i>brunnescens</i> G. F. Atk.	1. +	1. +				
4. <i>citrina</i> sensu auct. amer.	2. +	2. +		1. +		
5. <i>citrina</i> f. <i>lavendula</i> (Coker) Veselý		3. +				
6. <i>elongata</i> Peck	3. +?	4. +				
7. <i>flavoconia</i> G. F. Atk. var. <i>flavoconia</i>	4. +	5. +				
8. <i>flavoconia</i> var. <i>inquinata</i> Tulloss, Ovrebo & Halling				2. +	2.+	3. +
9. <i>flavorubens</i> (Berk. & Mont.) Sacc.	5. +	6. +	1.+	3. +		
10. <i>morrisii</i> Peck		7. +				
11. <i>novinupta</i> Tulloss & J. Lindgr.			2+	4. +		
12. <i>picea</i> Tulloss, Ovrebo & Halling						4. +
13. <i>porphyria</i> Alb. & Schwein.:Fr.	6. +					
14. <i>rubescens</i> sensu auct. E. USA	7. +	8. +				
15. <i>rubescens</i> var. <i>alba</i> Coker	8. +	9. +				
16. <i>salmonescens</i> Tulloss		10. +				
17. <i>spissa</i> var. <i>alba</i> Coker non Rick		11. +				
18. sp. 6		12. +				
19. sp. 10		13. +				
20. sp. 18		14. +				
21. sp. 19		15. +				
22. sp. 23		16. +				
23. sp. 36		17. +				
24. sp. 43		18. +				
25. sp. AZ10			3+	5. +		
26. sp. CR7					3.+	
27. sp. CR14					4.+	
28. sp. CR15					5.+	
29. sp. M11				6. +		

Appendix Table 2. *Amanita* section *Validae*—American regions of interest

Species	Québec	NJ/LI	AZ	Ctr. Méz.	CR	Col.
30. sp. M18				7. +		
31. sp. M28				8. +		
32. sp. M30				9. +		
33. sp. N20		19. +				

Appendix Table 3. *Amanita* section *Lepidella*—American regions of interest

Species	Québec	NJ/LI	AZ	Ctr. Méz.	CR	Col.
1. <i>abrupta</i> Peck	1. +	1. +				
2. <i>advena</i> Tulloss, Ovrebo & Halling					1. +	1. +
3. <i>atkinsoniana</i> Coker	2. +	2. +		1. +		
4. <i>canescens</i> Dav. T. Jenkins		3. +				
5. <i>chlorinosma</i> (Peck) Lloyd		4. +		2. +?		
6. <i>cinereopannosa</i> Bas		5. +				
7. <i>cokeri</i> (E. J. Gilbert & Kühner) E. J. Gilbert		6. +				
8. " <i>conara</i> " Tulloss, Halling & G. M. Muell. nom. prov.					2. +	
9. " <i>costaricensis</i> " Tulloss, Halling & G. M. Muell. nom. prov.					3. +	
10. " <i>crassifolia</i> " Bas nom. prov.		7. +				
11. <i>daucipes</i> (Mont.) Lloyd		8. +		3. +		
12. " <i>eremites</i> " Tulloss nom. prov.			1. +			
13. <i>limbatula</i> Bas		9. +				
14. <i>longipes</i> Bas ex Tulloss & Jenkins		10. +				
15. " <i>macerisolum</i> " Tulloss nom. prov.			2. +			
16. <i>microlepis</i> Bas		11. +				
17. <i>mutabilis</i> Beardslee		12. +				
18. <i>nauseosa</i> (Wakef.) D. A. Reid				4. +		
19. <i>onusta</i> (Howe) Sacc.	3. +	13. +				
20. <i>parva</i> (Murrill) Murrill		14. +				
21. <i>polypyraxis</i> (Berk. & Curt.) Sacc.		15. +		5. +	4. +	
22. <i>prairicola</i> Peck			3. +			

Appendix Table 3. *Amanita* section *Lepidella*—American regions of interest

Species	Québec	NJ/LI	AZ	Ctr. Méx.	CR	Col.
23. <i>ravenelii</i> (Berk. & Curt.) Sacc.		16. +				
24. <i>rhopalopus</i> Bas		17. +				
25. <i>salmonae</i> sensu Guzmán				6. +		
26. " <i>savannae</i> " Tulloss & Franco-Molano nom. prov.						2. +
27. <i>smithiana</i> Bas			4. +	7. +		
28. <i>subsolitaria</i> (Murrill) Murrill		18. +				
29. " <i>talamancae</i> " Tulloss, Halling & G. M. Muell. nom. prov.					5. +	
30. " <i>tephrea</i> " Bas nom. prov.		19. +				
31. <i>tephrea</i> sensu Cifuentes et al.				8. +		
32. <i>thiersii</i> Bas				9. +		
33. sp. 4		20. +				
34. sp. 5		21. +				
35. sp. 9		22. +				
36. sp. 11		23. +				
37. sp. 30		24. +				
38. sp. 38		25. +				
39. sp. 39		26. +				
40. sp. 40		27. +				
41. sp. AZ12			5. +			
42. sp. AZ26			6. +	10. +		
43. sp. CR18					6. +	
44. sp. M5				11. +		
45. sp. M23				12. +		
46. sp. M31 (<i>cf. griseofarinosa</i> ?)				13. +		
47. sp. M32 (<i>cf. rhopalopus</i>)				14. +		
48. sp. M33 (<i>cf. subsolitaria</i>)				15. +		
49. sp. M34 (<i>cf. pelioma</i>)				16. +		

Appendix Table 4. *Amanita* section *Amanita*—Asian regions of interest

Species	Japan	SWC	HP/UT	NWFP
1. <i>altipes</i> Zhu L. Yang et al.		1. +		
2. <i>concentrica</i> T. Oda et al.	1. +		1. +	
3. <i>emilii</i> Riel <i>sensu auct. ind.</i>			2. +	
4. " <i>emodipanthera</i> " Tulloss & Bhandary nom. prov.			3. +	
5. <i>farinosa sensu auct. asia.</i>	2. +	2. +		
6. <i>kwangsiensis</i> Y. C. Wang (= <i>sychnopyramis</i> f. <i>subannulata</i> Hongo)	3. +	3. +		
7. <i>melleiceps</i> Hongo	4. +			
8. <i>mira</i> Corner & Bas		4. +		
9. <i>muscaria</i> (L.:Fr.) Lam. var. <i>muscaria</i>	5. +		4. +	
10. <i>orientigemmata</i> Zhu L. Yang & Yoshim. Doi	6. +		5. +	
11. <i>pantherina sensu</i> S. P. Abraham & J. L. Kachroo			6. ?	1. +
12. <i>pantherina sensu</i> A. Kumar et al.			7. +	
13. <i>pantherina</i> var. <i>lutea</i> W. F. Chiu		5. +	8. +	
14. <i>parvipantherina</i> Zhu L. Yang et al.		6. +		
15. <i>pseudogemmata</i> Hongo	7. +	7. +		
16. <i>pseudopantherina</i> Zhu L. Yang nom. prov.		8. +		
17. <i>pulchella</i> S. Imai	8. +			
18. <i>rubrovolvata</i> S. Imai	9. +	9. +	9. +	
19. <i>rufoferruginea</i> Hongo	10. +	10. +		
20. <i>sinensis</i> Zhu L. Yang var. <i>sinensis</i>	11. +	11. +		
21. <i>subfrostiana</i> Zhu L. Yang		12. +		
22. <i>subglobosa</i> Zhu L. Yang		13. +		
23. V. K. Bhatt sp. 6			10. +	
24. Tulloss et al. sp. PAK5				2. +

Appendix Table 5. *Amanita* section *Validae*—Asian regions of interest

Species	Japan	SWC	HP/UT	NWFP
1. <i>citrina</i> var. <i>grisea</i> (Hongo) Hongo	1. +	1. +		
2. <i>flavipes</i> S. Imai	2. +	2. +	1. +	1. +
3. <i>fritillaria</i> (Berk.) Sacc. f. <i>fritillaria</i> (= <i>spissacea</i> S. Imai)	3. +	3. +	2. +	

Appendix Table 5. *Amanita* section *Validae*—Asian regions of interest

Species	Japan	SWC	HP/UT	NWFP
4. <i>fritillaria</i> f. <i>malayensis</i> Corner & Bas		4. +		
5. <i>fritillaria</i> <i>sensu</i> A. Kumar et al.			3. +	
6. <i>fulvaurantia</i> Locq. & T. N. Lakh.			4. +	
7. <i>innatifibrilla</i> Zhu L. Yang nom. prov.		5. +		
8. <i>orsonii</i> A. Kumar & T. N. Lakh.	4. +	6. +	5. +	2. +
9. <i>pilosella</i> Corner & Bas f. <i>pilosella</i>		7. +	6. +	
10. <i>sepiacea</i> S. Imai	5. +	8. +		

***Penicillium brevistipitatum*, a new species isolated from Jilin Province, China**

LONG WANG^{1,2} & WEN-YING ZHUANG^{1,*}

zhuangwy@sun.im.ac.cn

¹ Key Laboratory of Systematic Mycology & Lichenology

Institute of Microbiology Chinese Academy of Sciences, Beijing 100080, China

wl_dgk@yahoo.com.cn

² Graduate School of Chinese Academy of Sciences

Beijing 100039, China

Abstract — A unique *Penicillium* isolate from the soil of Mt. Changbai area, Jilin Province, China, with terverticillate and biverticillate penicilli, and unusually short and verrucose stipes is reported in this paper. It is described as *Penicillium brevistipitatum* sp. nov. and characterized by a moderate growth rate at 25°C without producing soluble pigment in the agar, sparse colonies on CA, extensive conidiophore fasciculation in dendroid or radial patterns on MEA, terverticillate and biverticillate appressed penicilli, extra short and verrucose stipes on CYA, narrow and long cylindrical phialides abruptly tapered to form long distinct collula, and ellipsoidal to ovoid smooth-walled conidia. This new species is morphologically similar to *P. coprophilum* and *P. glandicola*, which belong to Subgenus *Penicillium*, Section *Penicillium*, Series *Claviformia* according to the recent classification of Frisvad and Samson.

Key words — terverticillate penicillia, morphology, soil fungi

Introduction

The form genus *Penicillium* Link contains approximately 225 species, among which 45 species are associated with the teleomorph genus *Eupenicillium* F. Ludw., and 24 with *Talaromyces* C. R. Benj. (Pitt et al. 2000). Recently, 17 additional species have been reported (Frisvad et al. 1994, Peterson et al. 1999, Kong 2000, Peterson & Sigler 2002, Kong & Liang 2003, Peterson et al. 2003, Peterson 2004, Wang et al. 2004, Frisvad & Samson 2004). Of the four subgenera of *Penicillium*, subgenus *Penicillium* now consists of 58 species with a high diversity of morphology and production of secondary metabolites (Frisvad & Samson 2004). Most of these so-called terverticillate *Penicillium* species occur on food, feeds or dung (Frisvad et al. 2000). In this paper, we report on a new species of this subgenus isolated from soil that produces terverticillate and biverticillate penicilli on very short stipes.

*Author for correspondence

Materials and methods

The type isolate AS3.6887 was obtained from a soil sample collected in Mt. Changbai area, Jilin Province, in the northeast of China. The gross physiological characters of this isolate and the typical ones of its related species were examined carefully according to the methods and media for identification proposed by Frisvad & Samson (2004), with reference also to Pitt (1979) and Raper et al. (1949). The names of colors are based on Ridgway (1912). The materials for wet mounts were prepared from the colonies on CYA and immersed in lactophenol solution without dye. Microscopic characters were examined and photographed using Axioplan2 imaging and Axiophot2 universal Microscope (Carl Zeiss Shanghai Co. Ltd.).

Taxonomy

***Penicillium brevistipitatum* L. Wang & W.Y. Zhuang, sp. nov.**

Figs. 1–3

In agaro Czapek Yeast (CYA) 25°C post 7 dies: coloniae 36–38 mm diametro, tenues, leniter plicatae; umbonatae in medio; velutinae; sporulatio abunda, glauca; mycelium album; exsudatum praesens, incoloratum; pigmentum solubile absens; reversum umbrinum.

Conidiophora ex hyphis submersis, solitaria vel fasciculata in margine de coloniae adjacens; stipites verrucosi, (24–) 36–80 (–100) × 3.5–4.5 (–5.4) µm; penicilli praecipue terverticillati, interdum biverticillati, aliquando monoverticillati; rami 2 (–3) per stipitem, appressi, verrucosi, 12.0–18.0 × 3.2–4.0; metulae 2–4 per ramum, appressae, glabrae, 10.0–15.0 × 3.2–4.0 µm; phialides cylindricae, 2–6 per metulam, appressi, 11.0–15.0 × 2.0–2.5 µm, collula longa et distincta, ad 3.2–4.0 µm; conidia ellipsoidea ad ovoidea, 4.5–5.5 (–6.0) × 3.2–4.0 (–4.2) µm, levia, in catenis columnaris.

Holotypus hic designatus: HMAS 130354-1-4 (cultura viva AS 3.6887), isolatus ex solo, Provincia Jilin sinica, in Instituto Microbiologico Academiae Sinicae, Beijing, conservatur.

Etymology: *brevistipitatum* = short-stiped, referring to the short stipes of its conidiophores.

On Czapek agar (CA) at 25°C after 7days: Colonies 14–16 mm in diam., low and sparse, margins wide and irregular, slightly umbonate in the center; mostly subsurface, velutinous in central areas; conidiogenesis sparse, near Light Olive-Gray (R. Pl. LD); mycelia white; no exudate and pigment; reverse pale to Pale Ochraceous-Buff (R. Pl. XV).

On Czapek Yeast Autolysate agar (CYA) at 25°C after 7days: Colonies 36–38 mm in diam., low, slightly radially plicate; velvety, but fasciculate in the adjacent areas of colonies; conidiogenesis abundant, near Gnaphalium Green to Pea Green (R. Pl. XLVII); mycelia white; clear exudate moderately produced in central areas; no soluble pigment; reverse Snuff Brown to Saccardo's Umber (R. Pl. XXIX).

On Malt Extract Autolysate agar (MEA) at 25°C after 7days: Colonies 32–34 mm in diam., low, dendroidly and radially ridged at marginal areas, centers umbonate and

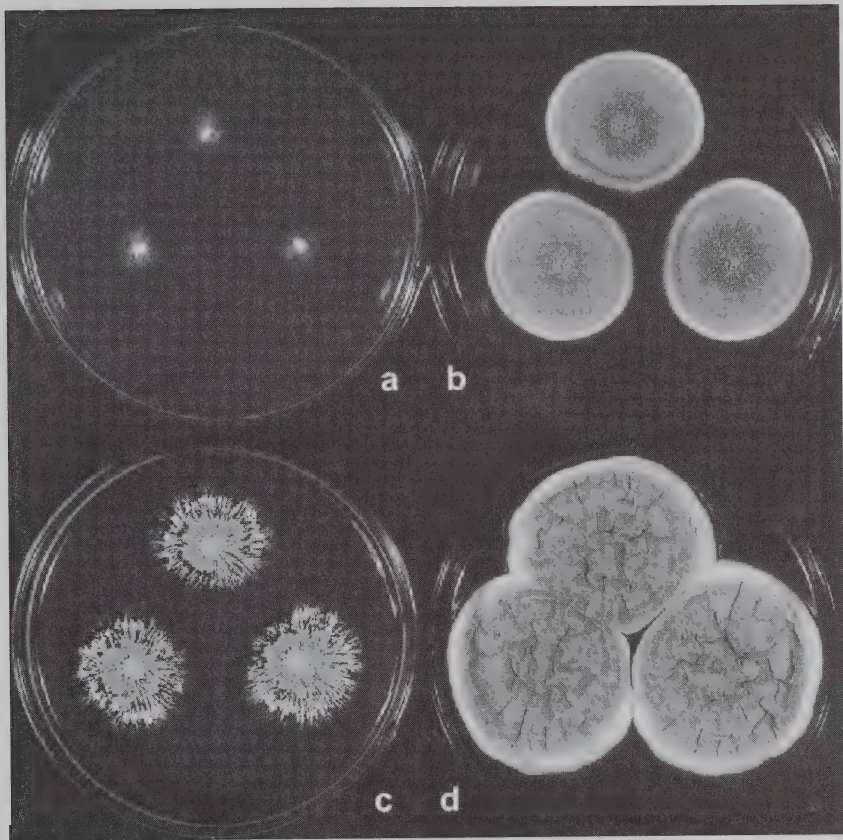


Fig. 1 *P. brevistipitatum*: a, b, c, d, colonies on CA, CYA, MEA and YES at 25°C after 7days.

slightly plicate, margins irregular or fimbriate; serried conidiophore fascicles aggregating or even anastomosing into dendroid and radial ridges at marginal areas, velutinous in central areas; conidiogenesis abundant, near Gnaphalium Green to Pea Green (R. Pl. XLVII); mycelium white; no exudate and soluble pigment; reverse Orange Brown to Mikado Brown, but Verona Brown (R. Pl. XXIX) beneath the bases of fascicles.

On Yeast Extract Sucrose agar (YES) at 25°C after 7days: Colonies 50-52 mm in diam.; moderately deep, radially and annularly densely sulcate; velutinous; conidiogenesis abundant, Gnaphalium Green to Pea Green (R. Pl. XLVII); no exudate and soluble pigment; reverse Ochraceous Tawny to Buckthorn Brown (R. Pl. XV).

On G25N at 25°C after 7days: Colonies 13-14mm, slightly deep, umbonate centrally, radially sulcate; velutinous; conidiogenesis absent; mycelium white; no exudate and soluble pigment; reverse Antique Brown (R. Pl. III).

On CYA at 37°C after 7days: No growth.

On CYA at 5°C after 7days: Growth weak, colonies sparse, about 2mm in diameter.

Conidiophores borne from the substratum, in fascicles and single; *stipes* (24-) 36-80 (-100) $\times$ 3.5-4.5 (-5.4) μm , verrucose on CYA, occasionally smooth-walled, but persistently smooth-walled on MEA; *penicilli* mainly terverticillate, biverticillate also present, and monoverticillate ones occasionally observed; *rami* 2 (-3) per stipe, appressed, verrucose, occasionally smooth-walled, 12.0-18.0 $\times$ 3.0-4.0 μm ; *metulae* 2-4 per ramus, appressed, smooth-walled, 10.0-15.0 $\times$ 3.0-4.0 μm ; *phialides* 2-6 per metula, cylindrical, 11.0-15.0 $\times$ 2.0-2.5 μm , abruptly tapered to form long distinct collula up to 3.0-4.0 μm ; *conidia* ellipsoidal to ovoid, smooth-walled, 4.5-5.5 (-6.0) $\times$ 3.0-4.0 (-4.2) μm , in loose columns up to 120 μm .

Discussion

Penicillium brevistipitatum is characterized by its moderate growth rate at 25°C, sparse colonies on CA, intensive conidiophore fascicles continuously gregarious into dendroid and radial patterns on MEA; terverticillate and biverticillate appressed penicilli, extra short and verrucose stipes on CYA while smooth on MEA, which is so distinctive among species of the Subgenus *Penicillium*, long narrow cylindrical phialides that abruptly tapered to form long distinct collula, and ellipsoidal to ovoid smooth-walled conidia. In a certain degree, the appressed terverticillate penicilli, grayish green conidia and fasciculate conidiophores of this new taxon resemble those of *P. coprophilum* (Berk. & M. A. Curtis) Seifert & Samson and *P. glandicola* (Oudem.) Seifert & Samson.

Although *P. brevistipitatum* and *P. coprophilum* both have relatively loose fasciculate conidiophores, uneven colony margins on MEA, dark brown color concentrated beneath the fascicle bases, and appressed penicilli with smooth-walled conidia, *P. coprophilum* grows much slowly and produces light brown soluble pigment, and possesses solitary conidiophore fascicles, which are of much longer and arranged in concentric rings rather than aggregated continuously or anastomosed in radial and dendroid ridges. The conidiophore stipes of *P. coprophilum* are even longer and persistently smooth-walled on CYA, and occasionally rough-walled on MEA; its phialides are obviously shorter and wider, and their collula are also much shorter, the shapes of its conidia are consistently ellipsoidal without any tendency to be ovoid. However, the stipes of the new taxon are very short and verrucose on CYA but persistently smooth on MEA; furthermore, its phialides are relatively slender and with long collula, its conidia are conspicuously ellipsoidal to ovoid.

The verrucose stipes and rami, fasciculate conidiophores of *P. brevistipitatum* are also similar to those of *P. glandicola*. However, the latter grows restrictedly and produces light red-brown soluble pigment, forms large, typical and well-defined coremia, or even synnemata with long stalks, giving colonies a granular appearance, while *P. brevistipitatum* does not. Although the stipes and rami of both are warty, those of *P. glandicola* are more intensively verrucose on all culture media, and its metulae are conspicuously roughened as well, moreover, large-dimensioned and even quaterverticillate penicilli are typically produced by *P. glandicola* and the elements

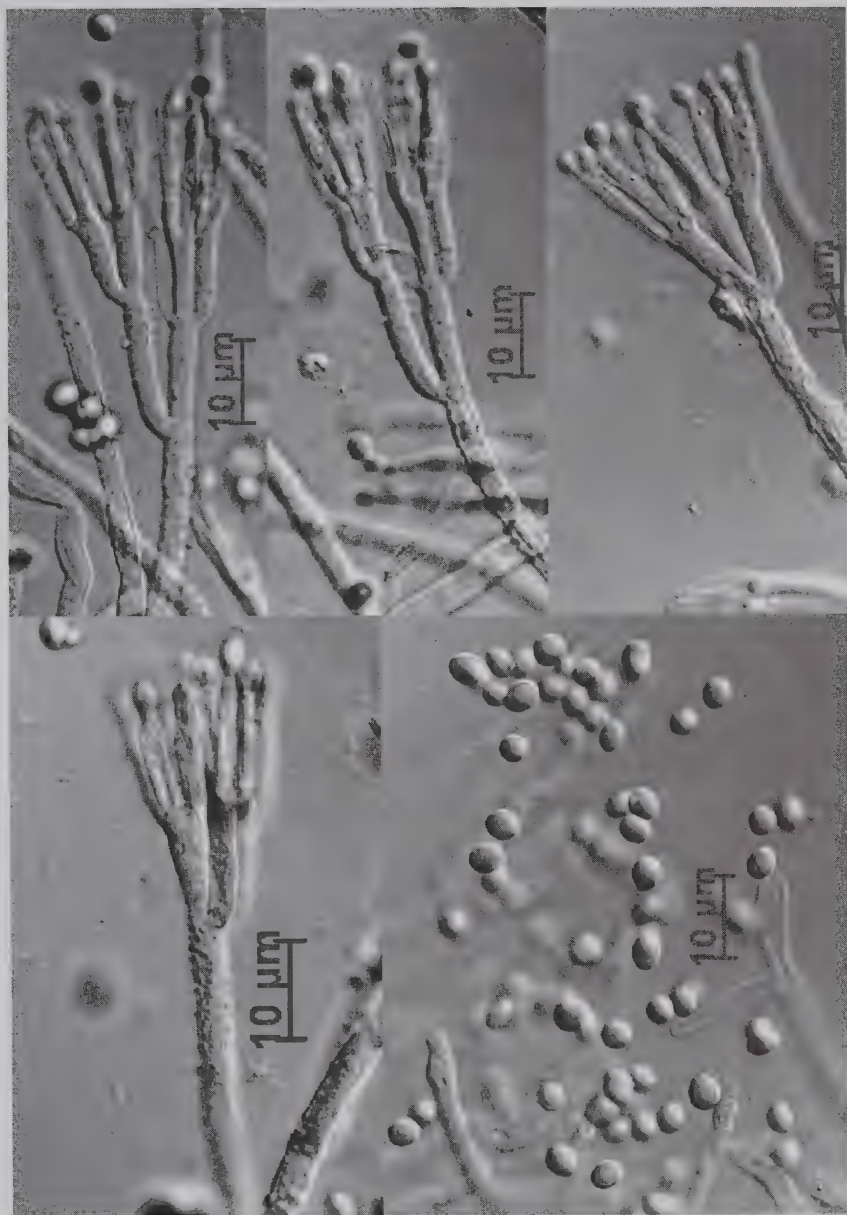


Fig. 2 penicilli and conidia of *P. brevistipitatum* from CYA.

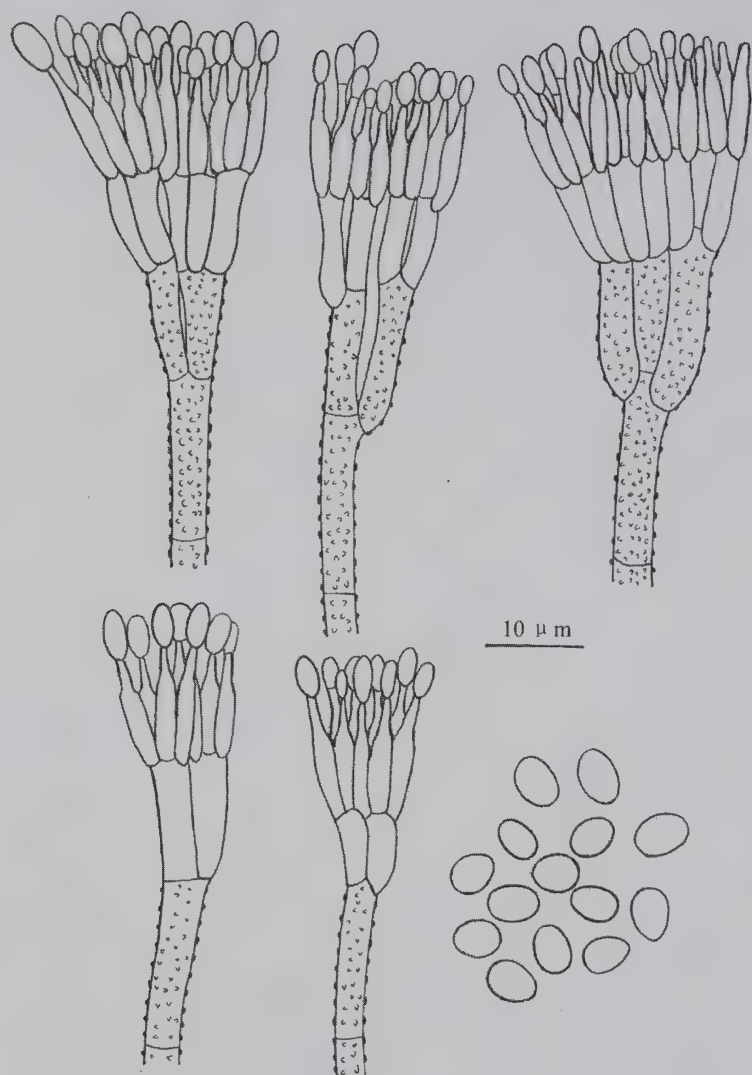


Fig. 3 Camera lucida drawings of conidiophores and conidia of *P. brevistipitatum* on CYA.

are characteristically robust, its phialides are ampuliform, shorter but wider, and also with shorter collula; in addition, its conidia are much smaller and in ellipsoidal shape. However, in *P. brevistipitatum*, no quaterverticillate penicilli are produced but monoverticillate ones occasionally present, and its stipes, penicilli, rami, metulae, and

phialides, as well as the roughness of their walls are obviously much delicate.

The moderate growth rate on the common culture media, reverse colors on CYA, lack of growth at 37°C, slight growth at 5°C, appressed elements of penicilli, dimensions of phialides and shapes of conidia show some similarities to *P. expansum* Link. But the latter grows much faster and luxuriantly on CA (some *P. expansum* strains grow even faster on CA, CYA and MEA), produces large conidiophore fascicles giving the colonies a “mealy” appearance, and abundant conidia in yellow-green color; while the isolate of the new species grows slowly and sparsely on CA with little conidiogenesis, produces short and small fascicles, and its conidial color is glaucous-green. The stipes of *P. expansum* are much longer and always smooth-walled, only occasionally roughened, its penicilli are larger, bearing numerous metulae and ampuliform to cylindrical phialides with short collula, its conidia are mainly ellipsoidal, only occasionally become globose at maturity. However, in the new taxon, much shorter stipes are produced with persistently verrucose walls, penicilli are relatively smaller, bearing fewer metulae and cylindrical phialides with long distinct collula, ellipsoidal and ovoid conidia are both commonly present in rather large dimensions. Moreover, *P. expansum* always very quickly causes an apple rot while this isolate never infects apples.

All these unique features elucidated above and the striking differences from its closely related species indicate that this isolate should be regarded as a new species. Sequence comparisons of nrDNA ITS1-5.8S-ITS2 and β -tubulin genes also support the separation of the new taxon from its three related fungi (unpublished). Although this species is based only on a single isolate, the combination of characters makes it very distinctive and its recognition at species level is therefore justified. *P. brevistipitatum* should be placed in Subgenus *Penicillium*, Section *Penicillium*, Series *Claviformia* according to the classification of Frisvad & Samson (2004); in Subgenus *Penicillium*, Section *Penicillium*, Series *Viridicata* according to Pitt (1979); and in Section *Asymmetrica*, Subsection *Fasciculata* in accordance with Raper et al. (1949).

Acknowledgements

Prof. Jian-yun Zhuang checked the Latin diagnosis, Dr. Xiang-Min Zhang took the photographs, Prof. R. P. Korf, Dr. S. W. Peterson and Dr. K. A. Seifert carefully reviewed the manuscript. This work was supported by National Natural Science Foundation of China (no. 30230020) and the Knowledge Innovation Program of Chinese Academy of Sciences.

Literature Cited

- Frisvad JC, Filtenborg O, Lund F, Samson RA. 2000. The homogeneous species and series in subgenus *Penicillium* are related to mammal nutrition and excretion. In: Samson RA, Pitt JI. (eds) *Integration of Modern Taxonomic Methods for Penicillium and Aspergillus Classification*. Harwood Academic Publishers, Amsterdam, pp 265–283.
- Frisvad JC, Samson RA. 2004. Polyphasic taxonomy of *Penicillium* subgenus *Penicillium*. A guide to identification of food and air-borne terverticillate penicillia and their mycotoxins. *Stud. Mycol.* 49: 1–173.
- Frisvad JC, Seifert KA, Samson RA, Mills JT. 1994. *Penicillium tricolor*, a new mould species from Canadian wheat. *Can. J. Bot.* 72: 933–939.

- Kong HZ. 2000. A new *penicillium* species isolated from Guizhou. *Mycosystema* 19: 1–2.
- Kong, HZ, Liang ZQ. 2003. A new *Penicillium* species isolated from Jiangxi, China. *Mycosystema* 22: 4–5.
- Peterson SW. 2004. Multilocus DNA sequence analysis shows that *Penicillium biourgeianum* is a distinct species closely related to *P. brevicompactum* and *P. olsonii*. *Mycol. Res.* 108: 434–440.
- Peterson SW, Corneli S, Hjelle JT, Miller-Hjelle, MA, Nowak DM, Bonneau PA. 1999. *Penicillium pimiteouiense*: a new species isolated from polycystic kidney cell cultures. *Mycologia* 91: 269–277.
- Peterson SW, Pérez J, Vega FE, Infante F. 2003. *Penicillium brocae*, a new species associated with the coffee berry borer in Chiapas, Mexico. *Mycologia* 95: 141–147.
- Peterson SW, Sigler L. 2002. Four new *Penicillium* species having *Thysanophora*-like melanized conidiophores. *Mycol. Res.* 106: 1109–1118.
- Pitt JI. 1979. The Genus *Penicillium* and Its Teleomorphic States *Eupenicillium* and *Talaromyces*. Academic Press, London.
- Raper KB, Thom C, Fennell DI. 1949. A Manual of the Penicillia. The Williams & Wilkins Company, Baltimore, Maryland.
- Ridgway R. 1912. Color Standards and Color Nomenclature. Ridgway, Washington, DC, Publ. by author.
- Wang L, Zhou HB, Frisvad JC, Samson RA. 2004. *Penicillium persicinum*, a new griseofulvin, chrysogine and roquefortine C producing species from Qinghai province, China. *Antonie*.

NATS truffle and truffle-like fungi 11: *Hymenogaster raphanodorus* sp. nov. (Cortinariaceae)

MATTHEW E. SMITH

mesmith@ucdavis.edu

*Department of Plant Pathology, University of California at Davis,
Davis CA 95616*

JAMES M. TRAPPE

trappej@onid.orst.edu

*Department of Forest Science, Oregon State University,
Corvallis, OR 97331-5752*

DAVID M. RIZZO

dmrizzo@ucdavis.edu

*Department of Plant Pathology, University of California at Davis,
Davis CA 95616*

Abstract—A new sequestrate species in the *Cortinariaceae*, *Hymenogaster raphanodorus* sp. nov., is described from xeric mixed woodland in Northern California. We compare *H. raphanodorus* with other known *Hymenogaster* spp. with respect to both morphology and ITS sequences.

Introduction

Xeric woodlands and chaparral plant communities dominate many of California's wild landscapes. These environments are often populated by woody plant genera known to host ectomycorrhizal fungi (EM) such as *Quercus*, *Pinus*, *Pseudotsuga*, *Arbutus*, and *Arctostaphylos* (Barbour 1988). The erratic weather conditions of California's arid woodlands cause many fungi to fruit irregularly. Consequently, many of these habitats remain mycologically under-explored. While dry environments may appear depauperate of fungal activity, recent work has shown that arid stands of *Quercus douglasii* Hook. & Arn. support a high diversity of EM fungi (M. Smith, unpublished data). It has been previously suggested that the sequestrate habit of truffles and false truffles arose in response to dry or erratic weather patterns (Thiers 1984); indeed many of the dominant genera of EM fungi associated with the drought-tolerant *Q. douglasii* produce sequestrate or resupinate fruiting bodies (M. Smith, unpublished data).

Hymenogaster is a genus of sequestrate basidiomycetes in the *Cortinariaceae*. Bougher and Castellano (1993) redefined *Hymenogaster* (sensu stricto) to include those taxa

with thick-walled, ellipsoid to fusiform spores with a large cup-like hilar appendix. A recent phylogenetic analysis of the *Cortinariaceae* suggests that *Hymenogaster s.s.* is part of a monophyletic group sharing common ancestry with the epigeous mushroom genera *Hebeloma* and *Naucoria* (Peintner et al. 2001).

In this paper we describe *Hymenogaster raphanodorus* sp. nov., a new sequestrate species sharing clear morphological affinities with known species of *Hymenogaster s.s.* and with a distinct odor of radishes reminiscent of many species in the sister genus *Hebeloma*.

Materials and Methods

Macroscopic characters, including colors, were described from dried material, notes, and pictures of the holotype. Colors were designated in accordance with ISCC-NBS terminology (Kelly & Judd, 1951). Microscopic characters were determined from hand-sectioned mounts in KOH. For molecular analysis, tissue was cut from the interior of basidiomata with a sterilized scalpel. Dry tissue was ground in 1.5 ml Eppendorf tubes and DNA was extracted using a modified CTAB method (Gardes & Bruns 1993). The ITS region of the ribosomal DNA was PCR amplified with primers ITS1F and ITS4B (Gardes & Bruns, 1993), visualized by gel electrophoresis on a 1.5% agarose gel, cleaned with Millipore Spin Columns (Millipore), and sequenced using the primers ITS1F and ITS4 (White et al. 1990). Sequences were edited using Sequencher v.4.1 (Gene Codes Inc.). Preliminary alignments of ca 550 bp of the ITS region (ITS1/5.8s/ITS2) were made with ClustalX (Thompson et al., 1997) followed by hand alignment in MacClade v4.03 (Sinauer Associates Inc.). Relationships between *H. raphanodorus*, *H. rubyensis*, and other *Hymenogaster* spp. were inferred based on maximum parsimony and neighbor-joining analyses performed with PAUP* 4.0b5 (Swofford, 2001).

Taxonomic Description

Hymenogaster raphanodorus M.E. Sm. & Trappe, sp. nov.

FIG. 1–2

Peridium albidum vel pallide griseobrunneolum, 150–300 μ m crassum; *pellis* pseudoparenchymata cellulis 5–10 (–30) μ m latis; *subpellis* prosenchymata hyphis hyalinis, 2.5–8 μ m latis. *Trama* glebae cana, brunnescens; *columella* absens. *Subhymenium* filamentum, 22–30 μ m crassum. *Basidia* cylindrica vel subcylindrica, 30–38 x 8–11 μ m, sterigmatibus duobus. *Fibulae* absens. *Sporae* subgloboso-subcitriformes, 18–20 (–21) x (14–) 16–19 μ m, ornamentum porcatum sed haud rostrum vel appendicem sterigmalem inclusens, obscure ferrugineae. *Odor* raphanoides. *Holotypus* hic designatus F.J.Z. Smith and E. Smith MES73. OSC#111301.

Basidiomata hypogeous, 10–20 mm broad, globose to subglobose, consistency firm but spongy. *Odor* raphanoid. **Peridium** 150–300 μ m thick, white to light grayish tan, discoloring brown in age; hyphae 2–10 μ m broad at the septa, often inflated to 5–15 μ m. **Gleba** whitish grey, with brown colors becoming apparent after exposure to air. **Trama** white becoming pale brown. **Columella** absent.

Peridiopellis $\pm$ 75–100 μ m thick, pale brown in KOH, a pseudoparenchyma with cells up to 30 μ m broad but mostly 5–10 μ m, intergrading gradually with the subpellis.



FIGS. 1–2. Holotype collection of *Hymenogaster raphanodorus*, (MES73, OSC#111301) FIG. 1. Fresh basidiomata of *H. raphanodorus*, scale in mm. FIG. 2. Basidiospores of *H. raphanodorus* in KOH, scale bar = 10 μ m.

Subpellis $\pm 75\text{--}150\text{ }\mu\text{m}$, pale brown in KOH, a prosenchyma of hyaline, thin-walled hyphae $2\text{--}5\text{ }\mu\text{m}$ in diameter; scattered thick-walled hyphae $2.5\text{--}8\text{ }\mu\text{m}$ broad and dark brown in KOH occasionally observed. **Glebal Trama** $\pm 10\text{--}60\text{ }\mu\text{m}$ thick, of hyphae $2\text{--}5\text{ }\mu\text{m}$ broad at the septa, with cells often inflated to $8\text{ }\mu\text{m}$ broad. **Subhymenium** weakly developed, in some locations 1–2 tiers of isodiametric cells $5\text{--}10\text{ }\mu\text{m}$ in diameter, in other locations a layer of appressed, interwoven hyphae.

Basidia cylindrical to clavate, $30\text{--}38 \times 8\text{--}11\text{ }\mu\text{m}$, with 2 sterigmata $\pm 0.5\text{--}1 \times 0.5\text{--}1.5\text{ }\mu\text{m}$. Basidia walls $\pm 0.5\text{ }\mu\text{m}$ thick. Basidia generally hyaline, but emerging young basidia occasionally yellow to yellow-brown in KOH. Reactions to Melzer's reagent not distinctive.

Cystidia none observed.

Clamp connections none observed.

Spores subglobose-citriform, $18\text{--}20\text{ (}\pm 21\text{)} \times 14\text{--}16\text{--}19\text{ }\mu\text{m}$, including ornamentation but not rostrum or sterigmal attachment, dark rusty brown in KOH and water, both singly and in mass; mean $Q\text{ (L:W)} = 1:1.16$; range = $1.05\text{--}1.24$; ($n=20$ spores); spore walls $\pm 1\text{--}2\text{ }\mu\text{m}$ thick, ornamented with low ridges $\pm 0.5 \times 0.5\text{ }\mu\text{m}$; apical rostrum cup-shaped, $1\text{--}2\text{ (}\pm 3\text{)}\text{ }\mu\text{m}$ tall and $1\text{--}2\text{ (}\pm 3\text{)}\text{ }\mu\text{m}$ broad, sterigmal attachment tapered, $1\text{--}2.5\text{ (}\pm 4\text{)}\text{ }\mu\text{m}$ tall $\times 1\text{--}2.5\text{ (}\pm 4\text{)}\text{ }\mu\text{m}$ broad at base.

Etymology Latin, *raphanus* (radish) + *odorus* (having an odor) in reference to the pronounced radish odor of fresh basidiomata.

Distribution, habitat, and season — *Hymenogaster raphanodorus* is known only from the holotype collection from a mixed woodland at an elevation of ca 150 m dominated by three ectomycorrhizal hosts: blue oak (*Quercus douglasii*), grey pine (*Pinus sabiniana*), and manzanita (*Arctostaphylos* spp.). The holotype collection included three basidiomata and was found in March under coniferous litter of *P. sabiniana*. *Q. douglasii* and *Arctostaphylos* spp. were growing nearby.

Collection Examined — Holotype: UNITED STATES, CALIFORNIA: Colusa Co., Green Valley Ranch, on the border of Mendocino National Forest near Stonyford. F.J.Z. Smith & E.C. Smith. MES73. 5 March 2004 (OSC #111301, Isotype SFSU).

Discussion

Hymenogaster raphanodorus is similar to the *Salix*-associated *H. rubyensis* Fogel & States (Fogel & States 2001). Both species occur in seasonally dry habitats and share a similar spore shape and 2-spored basidia. However, *H. raphanodorus* has larger spores with smaller spore ornamentation and a thicker peridium than *H. rubyensis* and was found in mixed woodland without any *Salix* hosts. Fresh basidiomata of *H. raphanodorus* have a distinct odor of radishes while *H. rubyensis* smells of green corn.

We sequenced the ITS region of the holotype of *H. raphanodorus* (MES73) (AY945302) and the paratype of *H. rubyensis* (Fogel 2698) (AY945303) and compared them with sequences of *Hymenogaster* from GenBank. While *H. raphanodorus* and *H. rubyensis* are morphologically similar, a comparison of rDNA sequences of the ITS region (ITS1/5.8s/ITS2) reveals that they are not closely related. Phylogenetic analysis indicates that *H. raphanodorus* is closely related to *H. gardneri* Zeller & C.W. Dodge, *H. parksii*

Zeller & C.W. Dodge, and *H. subalpinus* A.H. Sm., whereas *H. rubyensis* is more closely allied with *H. glacialis* Cázares & Trappe, *H. alnicola* A.H. Sm., and *H. tener* Berk. (data not shown).

This finding is significant because *H. subalpinus*, *H. parksii*, and *H. gardneri* were placed in a different clade than *H. glacialis*, *H. alnicola*, and *H. tener* in a recent analysis of relationships in the sequestrate *Cortinariaceae* (Peintner et al. 2001). Although the monophyly of *Hymenogaster* was not rejected by Peintner et al., the poor resolution of the relationships indicated that *Hymenogaster* may be polyphyletic. If further research proves that each of the two *Hymenogaster* clades deserves its own genus then *H. raphanodorus* would retain the epithet *Hymenogaster* due to its affinity with the type species (*H. bulliardii*), while *H. rubyensis* would belong to a newly segregated genus, possibly related to *Naucoria* in view of its association with *Salix*.

Morphologically, spores of *H. gardneri*, *H. parksii* and *H. subalpinus* are longer (17–27 μm) and have higher Q's (1.6–1.8) (Zeller and Dodge 1934, Smith 1966) than *H. raphanodorus*, with its spore length of 16–20 μm and a mean Q of 1.16. Moreover, *H. subalpinus* is associated with conifers, especially *Pseudotsuga menziesii*, and has a strong, unpleasant farinaceous odor (Smith 1966, J. Trappe unpublished data). *Hymenogaster gardneri* and *H. parksii* are both reported in association with oaks; their odor has not been reported.

Acknowledgements

The authors would like to thank P. Rogers and the University of Michigan Herbarium (MICH) for assistance in obtaining the paratype specimen of *Hymenogaster rubyensis*. C. Wellborn, K. Wellborn, and K. Wellborn provided logistical support for collections near Stonyford, California. Stephen Marks and his family generously provided access to Green Valley Ranch for collecting expeditions. G. W. Douhan and R.M. Davis provided valuable comments and assistance. D. Desjardin and R. Fogel contributed to this work by providing the authors with insightful reviews. This research was supported by grants to D. M. Rizzo by the National Science Foundation (DEB-99-81711) and to M. E. Smith by the Mycological Society of America, San Francisco Mycological Society, and Sonoma County Mycological Society (SOMA). J. M. Trappe's participation was supported in part by the U. S. Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon.

Literature Cited

- Barbour MG, Major J. (eds). 1988. Terrestrial Vegetation of California. California Native Plant Society, Sacramento.
- Bougher NL, Castellano MA. 1993. Delimitation of *Hymenogaster sensu stricto* and four new segregate genera. *Mycologia*. 85:273-293.
- Fogel R, States J. 2001. Materials for a hypogeous mycoflora of the Great Basin and adjacent cordilleras of the Western United States VI: *Hymenogaster rubyensis*, sp. nov. (*Basidiomycota*, *Cortinariaceae*). *Mycotaxon*. 80:333-337.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes—application to the identification of mycorrhizae and rusts. *Molecular Ecology*. 2:113-118.
- Kelly KL, Judd DB. 1955. The ISCC-NBS Method of Designating Colors and a Dictionary of Color Names. U.S. Department of Commerce, National Bureau of Standards Circular 553. 1-158.

- Peintner U, Bougher NL, Castellano M, Moncalvo M, Moser M, Trappe J, Vilgalys R. 2001. Multiple origins of sequestrate fungi related to *Cortinarius* (*Cortinariaceae*). *American Journal of Botany*. 88:2168-2179.
- Smith AH. 1966. Notes on *Dendrogaster*, *Gymnoglossum*, *Protoglossum* and species of *Hymenogaster*. *Mycologia*. 58:100-124.
- Swofford, DL. (2001) PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods), Version 4.0b10. Sunderland, MA, USA. Sinauer Associates, Inc.
- Thiers HD. 1984. The Secotoid Syndrome. *Mycologia*. 76:1-8.
- Thompson JD, Gibson TJ, Plewniak, F, Jeanmougin F, Higgins DG. 1997. The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research*. 24: 4876-4882.
- White TJ, Bruns TD, Lee S, Taylor JW. 1990. Amplification of fungal ribosomal RNA genes for phylogenetics. In *PCR Protocols: a Guide to Methods and Applications*. Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds). 315-322. Academic Press, Inc., New York.
- Zeller S.M. & Dodge G.W. 1934. *Hymenogaster* and related genera. *Annals of the Missouri Botanical Garden*. 21: 625-708.

Genetic similarity and taxonomic relationships within the genus *Pleurotus* (higher Basidiomycetes) determined by RAPD analysis

MIRJANA STAJIĆ^{1,2}, JOHANNES SIKORSKI²,
SOLOMON P. WASSER² & EVIATAR NEVO²

¹stajicm@bfbot.bg.ac.yu

*Institute of Botany, Faculty of Biology, University of Belgrade,
Takovska 43, 11000 Belgrade, Serbia and Montenegro*

²*Institute of Evolution, University of Haifa
Mt. Carmel, Haifa, Israel.*

Abstract—Random amplified polymorphic DNA polymerase chain reactions (RAPD-PCR) were used to assess the genetic diversity among 37 strains of 10 *Pleurotus* species from different geographical and ecological areas worldwide, as well as to show the extent of accordance between these molecular data and previously obtained morphological and physiological data. The RAPD dendrogram obtained by using a UPGMA program, grouped the investigated strains into 6 clusters. One strain of *P. cystidiosus* and 3 strains of *P. smithii*, all originating from Israel, were grouped together, while another strain of *P. cystidiosus*, which originated from the USA, was clearly separated, which can be explained by the fact that ecological factors and geographical separation have a strong effect on the outcome of similar studies. Strains of *P. pulmonarius* and *P. djamor* showed also that geographical separation causes genetic differences. Cultivated strains with unknown morphologies were included in the study and caused serious difficulties in the interpretation of results.

Key words—genomic DNA polymorphism

Introduction

The genus *Pleurotus* is a heterogeneous group of increasing economic value. Several species are of nutritional and/or medicinal importance (Gunde-Cimerman 1999, Guzman 2000, Cohen et al. 2002). Some *Pleurotus* species have the ability to absorb microelements from the different cultivation media, and thus they may present an excellent dietary source (Stajić et al. 2002).

Due to *Pleurotus*' ability to efficiently degrade natural lignin by excreting four ligninolytic enzymes [laccase (Lac), manganese-dependent peroxidase (MnP), versatile peroxidase (VP), and aryl-alcohol oxidase (AAO)] (Muñoz et al. 1997), some species of the genus *Pleurotus* are commercially cultivated on different raw lignocellulosic materials (sawdust, paper, agricultural wastes, and other potential environmental pollutants) produced in enormous amounts worldwide.

However, the systematic position of some *Pleurotus* taxa was not well determined for a long time. Some taxonomic groups classified previously by morphological criteria were later shown, by the aid of molecular methods, to include several taxonomic entities (Brasier 1997).

Recently, several new taxonomic achievements in the genus *Pleurotus* were made by adding both mating and molecular studies. According to morphological characters, the subgenus *Coremiopleurotus* includes six morphological taxa (*P. cystidiosus*, *P. abalonus*, *P. smithii*, *P. fuscusquamulosus*, *P. gemmellari*, and *P. australis*). After testing their mating compatibility, three intersterility groups were revealed [*P. australis*, *P. cystidiosus* sensu lato, and *P. smithii* (Zervakis 1998)]. However, according to analysis of internal transcribed spacer 2 regions (ITS) sequences of ribosomal DNA (rDNA) (Zervakis et al. 2004), five phylogenetic species were presented within the subgenus *Coremiopleurotus* (*P. australis*, *P. abalonus*, *P. fuscusquamulosus*, *P. smithii*, and *P. cystidiosus*). Previously defined mating groups were found to be either paraphyletic (Zervakis & Balis 1996, Brasier 1997) or to contain several distinct molecular lineages (Vilgalys & Sun 1994, Isikhuemhen et al. 2000). However, for a long time, it was unclear, whether *P. salignus* and *P. ostreatus* were different species or if they should have been regarded as synonymous (Bresinsky et al. 1977, Hilber 1982, Moser 1983, Watling & Gregory 1989).

The aim of this study was to investigate molecular-genomic polymorphism among selected *Pleurotus* species and strains in order to confirm the accuracy of their systematic position, previously obtained on the basis of their morphology and ability of ligninolytic enzyme production.

Materials and methods

Organisms and growth conditions

The investigated species and strains of the genus *Pleurotus* and their origin are shown in Table 1. These cultures are preserved on worth agar medium (WA) in the culture collection of the Institute of Evolution, University of Haifa (HAI), and they are documented in the Catalogue of Cultures (Wasser et al. 2002).

Table 1. Investigated *Pleurotus* species and strains

Scientific name of species	HAI number of strains	Origin of strains
<i>P. cornucopiae</i> (Paulet) Rolland	32	Cultivated strain, Belgium.
	586	KW, A. S. Buchalo (88), 1999. V. D. Lozovoy (444), Sochi, Russia, 1979. on <i>Ulmus</i> sp.
<i>P. citrinopileatus</i> Singer	602	Cultivated strain, England
	435	Cultivated strain, England
<i>P. cystidiosus</i> O.K. Miller	95	Israel, Haifa, park, on <i>Schinus terebinthifolius</i> Raddi
	607	KW, A. S. Buchalo (190), 1999. CCBAS, M. Semerdzieva (466), 1981. Mississippi-delta, Louisiana, USA

<i>P. djamor</i> (Rumph. ex Fr.) Boedijn	485	Cultivated strain, Hawaii, Nextlab
	46	Mexico
<i>P. eryngii</i> (DC.) Quél. var. <i>eryngii</i>	193	Ukraine., Kherson region, Chaplinka district, Askania-Nova, on <i>Stipa</i> sp.
	201	Israel, Menahemya, on <i>Ferula</i> sp.
	356	Israel, Gevaot Merar, near Gedera, on <i>Ferula</i> sp.
	507	Cultivated strain, Hawaii, Nextlab
	616	Israel, Tabor, on <i>Ferula</i> sp.
	711	Israel, Tel Hazor, on <i>Ferula</i> sp.
	716	Israel, Gilboa, on <i>Ferula</i> sp.
	728	Israel, Lahav, on <i>Ferula</i> sp.
<i>P. eryngii</i> var. <i>tingitanus</i> Lewinsohn	555	Israel, Sataf, on <i>Ferula tingitana</i> L.
<i>P. ostreatus</i> (Jacq.) P. Kumm.	207	Ukraine, Transcarpathian region, Beregovo district, village Ivanovka, on <i>Quercus robur</i> L.
	221	Israel, Atlit, park, on <i>Salix</i> sp.
	234	Cultivated strain, Hungary.
	290	Cultivated strain, England.
	387	Cultivated strain (HK-35), Yugoslavia.
	493	Cultivated strain, Hawaii, Nextlab
	494	Cultivated strain, Hawaii, Nextlab
	495	Cultivated strain, Hawaii, Nextlab
	592	KW, A. S. Buchalo (1300).
<i>P. florida</i> Eger, nom. nud.	393	Cultivated strain, England.
<i>P. pulmonarius</i> (Fr.) Quél.	509	Cultivated strain, Hawaii, Nextlab
	572	KW, A. S. Buchalo (194), -CCBAS, M. Semerdzieva (478).
	573	KW, A. S. Buchalo (111), -VKM (F-2006). Coll. Russia, Sochi.
<i>P. salignus</i> (Pers.) P. Kumm.	326	Israel, Dan Natural Reserve, Tel Dan, on <i>Salix</i> sp.
	328	Israel, Dan Natural Reserve, Tel Dan, on <i>Salix</i> sp.
<i>P. salmoneo-stramineus</i> Lj. N. Vassiljeva	77	Cultivated strain (M2700), Belgium
	327	Germany
<i>P. smithii</i> Guzmán	138	Israel, Haifa, Carmel park on <i>Morus alba</i> L.
	140	Israel, Haifa, Carmel, Moria St. park, on <i>Morus alba</i>
	141	Israel, Jerusalem, on <i>Schinus terebinthifolius</i>

Isolation of genomic DNA

Strains were incubated on Petri dishes containing WA for 21 days at 25°C. Mycelia were harvested, frozen in liquid nitrogen, and ground to powder in a mortar. The DNA was isolated as described by Weining & Henry (1995). The purity and quality of the DNA was determined spectrophotometrically and by agarose gel electrophoresis. Standard 10 ng μ l⁻¹ DNA working solutions were prepared for each sample in TE buffer and were kept at 4°C for further tests.

RAPD analysis

Random amplified polymorphic DNA polymerase chain reactions (RAPD-PCR) (Williams et al. 1990) were carried out in 20 μ l reaction volume containing 30 ng genomic DNA, 10 x PCR buffer Mg free, 50 mM MgCl₂, 2 mM dNTP, Taq polymerase (1 U μ l⁻¹) (Biotools, Madrid), 12 ng primer [University of British Columbia (UBC), Canada], and double distilled water. Six primers, which gave well-resolved bands in gel electrophoresis were used: **1.** UBC 155 (CTG GCG GCT G); **2.** UBC 215 (TCA CAC GTG C); **3.** UBC 250 (CGA CAG TCC C); **4.** UBC 310 (GAG CCA GAA G); **5.** UBC 335 (TGG ACC ACC C); and **6.** UBC 458 (CTC ACA TGC C). Amplification was performed in a GeneAmp PCR System 9700 thermal cycler: one cycle at 92°C for 3 min, 45 cycles at 92°C for 30 sec, 42°C for 1 min, and 72°C for 1 min, and one cycle at 72°C for 10 min. Amplified fragments were resolved on a 1.2% agarose gel. We performed several control experiments including (i) separate RAPD-PCR runs on the DNA of the same isolates, (ii) variation of DNA concentration, and (iii) the analyses of RAPD-PCR products in separate agarose gels to ensure the reproducibility of the RAPD patterns. A size marker (Ladder Mix, MBI Fermentas) was used as a reference in all gels. The RAPD patterns were analyzed with the software Gene ImagIR version 3.52 (Scanalytics) and exported into the Treecon software (Van de Peer & De Wachter 1994) to generate an Unweighted Pair Group Method with Average Means (UPGMA) dendrogram from a distance matrix (Nei & Li 1979).

Results

All strains included in this study showed unique banding patterns, as observed from amplification band comparisons a total of 6 RAPD-PCR primers. Altogether, an average of 46 ± 6 bands per isolate (minimum 25 bands and maximum 59 bands) was obtained in a total of 260 different band positions. Along the topology of an UPGMA dendrogram, we defined six clusters A-F, in order to yield clusters of previously morphologically defined species (Fig.1). These clusters split from each other at a genetic dissimilarity distance of approximately 0.54-0.64 (Fig.1). Basically, a good correlation was observed between morphological and molecular grouping of strains. However, several inconsistencies were noticed. Both strains of *P. salignus* (HAI 326 and HAI 328) clustered within the group of *P. ostreatus* (cluster A, Fig.1). Two strains of *P. ostreatus* (HAI 290 and HAI 592) were in the *P. eryngii* cluster (cluster B). *P. smithii* strains were grouped in the same cluster (cluster C) with one of the *P. cystidiosus* strains (HAI 95 from Israel), which was clearly separated by another lineage made up by one *P. cystidiosus* strain from the USA (HAI 607). All *P. pulmonarius* strains were grouped together (cluster D), with HAI 509 being clearly separated from strains HAI 572 and

573. Both *P. citrinopileatus* strains clustered together with the *P. salmoneostramineus* strain (HAI 77), which is thus clearly separated from the other *P. salmoneostramineus* strain (HAI 327). The two *P. djamor* strains, HAI 46 and 485, were grouped closely together with the *P. cornucopiae* strain, HAI 32 (cluster F), which was then clearly separated from the other *P. cornucopiae* strain, HAI 586.

Discussion

General congruence of molecular and morphological classification

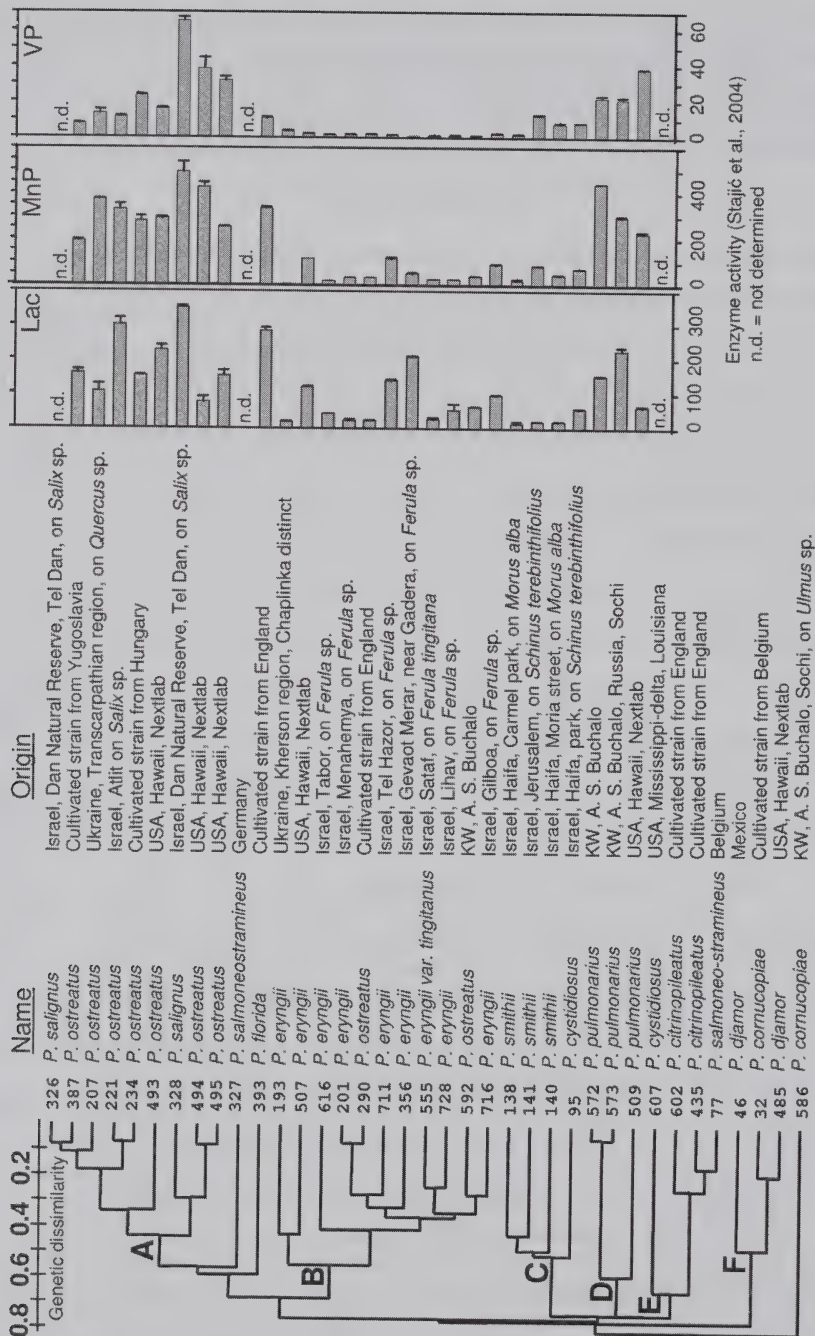
Basically, a strong correlation was found between morphological and molecular criteria, supporting previous studies (Iracabal et al. 1995, Zervakis et al. 2004). We found both *P. salignus* strains (HAI 326 and 328) to cluster within the group of *P. ostreatus* (cluster A, Fig. 1). This supports the conclusions of Hilber (1982) and Watling & Gregory (1989) that *P. salignus* is in fact a synonym of *P. ostreatus*.

In a few cases, the molecular-genomic relationships among strains did not match the morphological groupings. Our data showed that two strains of *P. salmoneostramineus* (HAI 77 and 327) as well as two strains of *P. cornucopiae* (HAI 32 and 586) were split into different genomic clusters representing basically different morphospecies. Additionally, two *P. ostreatus* strains, HAI 290 and 592, clustered not only apart from all other *P. ostreatus* strains (cluster A, Fig. 1), but grouped nicely within the *P. eryngii* cluster B (Fig. 1). The latter case could be explained by previous misidentification. These strains have been received as mycelia culture and their classification history is unknown. As shown in *P. eryngii* species-complex, identification mistakes are easily made due to variations in morphology (Lewinsohn et al. 2002), isoenzymes (Zervakis et al. 1994), and genetic characteristics (Lewinsohn et al. 2001) in response to geographical and/or ecological differences in their environments, i.e., geographic variation.

In order to better clarify the observed discrepancies between morphological and molecular-genomic criteria, we added physiological data available for nearly all strains for comparison (Fig. 1). Stajić et al. (2004) have determined the activities of the ecologically important ligninolytic enzymes: laccase (Lac), manganese-dependent peroxidase (MnP), and versatile peroxidase (VP). Basically, in a comparison of all three enzymes, *P. ostreatus* strains showed high-enzyme activities compared to *P. eryngii* (Fig. 1). Strains HAI 290 and 592, morphologically classified as *P. ostreatus*, however, showed the same low-enzyme activities of the *P. eryngii* strains they clustered with (Fig. 1), compared to the high-enzyme activities of the *P. ostreatus* group. These results support the grouping obtained by RAPD analysis, and thus we propose that the *P. ostreatus* strains, HAI 290 and 592, should be reclassified as *P. eryngii* strains.

The enzyme activities of strain HAI 328, classified as *P. salignus*, shows similar high-enzyme activities as the *P. ostreatus* strains with which it genomically clusters. This additionally confirms that *P. salignus* and *P. ostreatus* should be considered synonyms of the same species (Hilber 1982, Watling & Gregory 1989).

Strain HAI 393, which was morphologically described as *P. florida*, clusters close to, but yet separated from all other *P. ostreatus* strains, indicating an ongoing evolutionary separation process of these two lineages (A; Fig. 1). This was confirmed by mating experiments (Hilber 1982, Bresinsky et al. 1987). Likewise, Gonzalez & Labarère (2000) stated that *P. ostreatus* and *P. florida* represent a single species according to



obtained results by investigations of sequences of the V4, V6, and V9 domains of the mitochondrial small subunit rRNA.

Geographical and ecological influences on genetic characters

In the case of three strains of *P. pulmonarius* as well as of two strains of *P. djamor*, it was shown that both geographical separation and different ecology factors cause genetic differences. Although both strains of *P. pulmonarius* and *P. djamor* strains made up each unique cluster, D and F, respectively, the within-species distance between strains was large (D~40%), especially between *P. pulmonarius* strain HAI 509 and two other strains (HAI 572 and 573), and two strains of *P. djamor* (HAI 46 and 485), respectively. The observed large within-species genomic distance correlates with geographic separation and probably also with ecological divergence, and might finally terminate in speciation.

Despite molecular techniques, the taxonomic relationships between *P. cystidiosus* and *P. smithii* are not yet completely resolved. In the RAPD study of Capelari & Fungaro (2003), the three strains of *P. smithii* (from Mexico) intermingled with 9 strains of *P. cystidiosus* (from Brazil, China, Greece, Japan, Thailand, and the USA), supporting the proposal of Hilber (1997) that *P. smithii* should be considered synonymous with *P. cystidiosus*. In another study, however, Zervakis et al (2004) clearly separated *P. cystidiosus* and *P. smithii* strains on the basis of ITS sequences, yet the two species were closely related to each other in comparison to other species of the *Coremiopleurotus* taxa. Recently, we reported for the first time, on a morphological basis, the presence of *P. cystidiosus* (1 strain) and *P. smithii* (3 strains) in Israel (Stajić et al. 2003). In our RAPD study, these four strains grouped together in a unique cluster (C; Fig. 1), while the *P. cystidiosus* strain from Haifa (HAI 95) was clearly separated from the *P. cystidiosus* (HAI 607), isolated in the USA. Linking these results to the results of Capelari & Fungaro (2003) and Zervakis et al (2004), the following might describe the relationship between *P. cystidiosus* and *P. smithii*. Both taxa are very similar to each other, and the origin (i.e., biogeography and ecology) of the strains might have a strong impact on the outcome of similar studies. Lewinsohn et al (2000) showed the strong impact of ecology on different strains of *P. eryngii*, which, via selection, might influence genetic characteristics. Thus, only a large study of all available isolates of *P. cystidiosus* and *P. smithii*, comprising a variety of geographical and ecological origins, might give more insight into the relationship between *P. cystidiosus* and *P. smithii*.

Conclusions

Results of these investigations showed some incompatibilities between the morphological determination, on the one hand, and the physiological-genomical determination, on the other hand, of *Pleurotus* species and strains. This confirms the current view that for a precise affiliation of strains to a taxonomic group or evolutionary lineage, morphological, behavioural, and molecular criteria should be applied.

Fig. 1. Taxonomic relationships among investigated *Pleurotus* species and strains based on the results of: a) RAPD-PCR analysis; b) study of Lac production; c) study of MnP production, and d) study of VP production by them.

Acknowledgments

The authors thank Dr. Georgios I. Zervakis and Prof. Giuseppe Venturella for useful comments and review of the manuscript.

Literature cited

- Brasier CM. 1997. Fungal species in practice: identifying species units in fungi. In: "Species: The Units of Biodiversity". Edited by Claridge MF, Dawah HA & Wilson MR. Chapman & Hall, London: 135-170.
- Bresinsky A, Hilber O, Molitoris HP. 1977. The genus *Pleurotus* as an aid for understanding the concept of species in Basidiomycetes. In: "The Species Concept in Hymenomycetes". Edited by Cléménçon H. Bibliotheca Mycologica 61: 229-258.
- Bresinsky A, Fischer M, Meixner B, Paulus W. 1987. Speciation in *Pleurotus*. Mycologia 79 (2): 234-245.
- Capelari M, Fungaro MH. 2003. Determination of biological species and analysis of genetic variability by RAPD of isolates of *Pleurotus* subgenus *Coremiopleurotus*. Mycological Research 107 (9): 1050-1054.
- Cohen R, Persky L, Hadar Y. 2002. Biotechnological applications and potential of wood-degrading mushrooms of the genus *Pleurotus*. Applied Microbiology and Biotechnology 58: 582-594.
- Gonzalez P, Labarère J. 2000. Phylogenetic relationships of *Pleurotus* species according to the sequence and secondary structure of the mitochondrial small-subunit rRNA V4, V6 and V9 domains. Microbiology 146: 209-221.
- Gunde-Cimerman N. 1999. Medicinal Value of the Genus *Pleurotus* (Fr.) P. Karst. (Agaricales s. l., Basidiomycetes). The International Journal of Medicinal Mushrooms, 1: 69-80.
- Guzman G. 2000. Genus *Pleurotus* (Jacq.:Fr.) P. Kumm. (Agaricomycetidae): Diversity, Taxonomy Problems, and Cultural and Traditional Medicinal Uses. The International Journal of Medicinal Mushrooms 2: 95-123.
- Hilber O. 1982. Die Gattung *Pleurotus*. Edited by Cramer J. Bibliotheca Mycologica 87.
- Hilber O. 1997. The Genus *Pleurotus* (Fr.) Kummer (2). Erschienen im Selbstverlag, Kelheim.
- Iracabal B, Zervakis G, Labarère J. 1995. Molecular systematics of the genus *Pleurotus*: analysis of restriction polymorphisms in ribosomal DNA. Microbiology 141: 1479-1490.
- Isikhuemhen SO, Moncalvo JM, Nerud F, Vilgalys R. 2000. Mating compatibility and phylogeography in *Pleurotus tuberregium*. Mycological Research 104 (6): 732-737.
- Lewinsohn D, Wasser SP, Hadar Y, Nevo E, Beharav A. 2000. Ecogeographical variation in the *Pleurotus eryngii* complex in Israel. Mycological Research 104: 1184-1190.
- Lewinsohn D, Nevo E, Wasser SP, Hadar Y, Beharav A. 2001. Genetic diversity in populations of the *Pleurotus eryngii* complex in Israel. Mycological Research 105 (8): 941-951.
- Lewinsohn D, Wasser SP, Reshetnikov SV, Hadar Y, Nevo E. 2002. The *Pleurotus eryngii* species-complex in Israel: distribution and morphological description of a new taxon. Mycotaxon 81: 51-67.
- Moser M. 1983. Die Röhrlinge und Blätterpilze (Polyporales, Boletales, Agaricales, Russulales). Edited by Fischer G. Verlag Stuttgart. New York.
- Muñoz C, Guillen F, Martínez TA, Martínez JM. 1997. Induction and characterization of laccase in the ligninolytic fungus *Pleurotus eryngii*. Current Microbiology 34: 1-5.
- Nei M, Li WH. 1979. Mathematical model for studying genetic variation in terms of restriction endonucleases. Proceedings of The National Academy of Sciences, USA 76: 5269-5273.
- Stajić M, Milenković I, Brčeski I, Vukojević J, Duletić-Laušević S. 2002. Mycelial growth of

- edible and medicinal oyster mushroom [*Pleurotus ostreatus* (Jacq.: Fr.) Kumm.] on selenium-enriched media. *International Journal of Medicinal Mushrooms* 4: 241-244.
- Stajić M, Wasser SP, Reshetnikov SV, Nevo E, Guzmán G. 2003. First record of the natural occurrence of *Pleurotus cystidiosus* and *P. smithii* in Israel and Asia. *Israel Journal of Plant Sciences* 51: 237-244.
- Stajić M, Persky L, Cohen E, Hadar Y, Brčeski I, Wasser SP, Nevo E. 2004. Screening of the laccase, manganese-peroxidase, and versatile peroxidase activities of the genus *Pleurotus* in media with some plant raw materials as carbon sources. *Applied Biochemistry and Biotechnology* 117 (3): 155-164.
- Van de Peer Y, De Wachter R. 1994. TREECON for Windows: a software package for the construction and drawing of evolutionary trees for the Microsoft Windows environment. *Computer Applied Bioscience* 10: 569-70.
- Vilgalys R, Sun LB. 1994. Ancient and recent patterns of geographic speciation in the oyster mushroom *Pleurotus* revealed by phylogenetic analysis of ribosomal DNA sequences. *Proceedings of The National Academy of Sciences, USA* 91: 4599-4603.
- Zervakis GI, Sourdis J, Balis C. 1994. Genetic variability and systematics of eleven *Pleurotus* species based on isoenzyme analysis. *Mycological Research* 98 (3): 329-341.
- Zervakis GI, Balis C. 1996. A pluralistic approach in the study of *Pleurotus* species with emphasis on compatibility and physiology of the European morphotaxa. *Mycological Research* 100 (6): 717-731.
- Zervakis GI. 1998. Mating competence and biological species within the subgenus *Coremiopleurotus*. *Mycologia* 90: 1063-1074.
- Zervakis GI, Moncalvo JM, Vilgalys R. 2004. Molecular phylogeny, biogeography and speciation of the mushroom species *Pleurotus cystidiosus* and allied taxa. *Microbiology* 150 (3): 715-726.
- Wasser SP, Dukman I, Lewinson D. 2002. Catalogue of cultures (Higher Basidiomycota). International Center for Cryptogamic Plant and Fungi, Institute of Evolution, University of Haifa.
- Watling R, Gregory MN. 1989. 6/*Crepidotaceae*, *Pleurotaceae* and other pleurotoid agarics. Royal Botanic Garden Edinburgh.
- Weining S, Henry RJ. 1995. Molecular analysis of the DNA polymorphism of wild barley (*Hordeum spontaneum*) germplasm by the polymerase chain reaction. *Genetic Resources and Crop evolution* 42: 273-281.
- Williams JGK, Kubelik AR, Livak KJ, Rafalski JA, Tingey SV. 1990. DNA polymorphism amplified by arbitrary primers are useful as genetic markers. *Nucleic Acid Research* 18: 6531-6535.

Type studies on *Albatrellus henanensis* and *A. jianfenglingensis*

HUAN-DI ZHENG

hdzheng@mail.kib.ac.cn

Kunming Institute of Botany, Chinese Academy of Sciences

Kunming, Yunnan, 650204, P. R. China

Graduate School of the Chinese Academy of Sciences

Beijing, 100039, P. R. China

PEI-GUI LIU*

pgliu@mail.kib.ac.cn

Kunming Institute of Botany, Chinese Academy of Sciences

Kunming, Yunnan, 650204, P. R. China

Abstract—The holotypes of *Albatrellus henanensis* and *A. jianfenglingensis* have been critically restudied. *A. henanensis* is a synonym of *A. cristatus* based upon its diagnostic characteristics. *A. jianfenglingensis* is transferred to the genus *Polyporus* s. str. as *P. jianfenglingensis* comb. nov. Important characters observed from the types are illustrated in line drawings.

Key words—*Albatrellaceae*, taxonomy, China

Introduction

During the study of specimens of the genus *Albatrellus* Gray, the holotypes of *A. henanensis* and *A. jianfenglingensis* have been critically reexamined. Detailed illustrations and descriptions are presented and the taxonomic status of these species is discussed.

Materials and Methods

The specimens examined are preserved either in HMAS (Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences) or HMIGD (Mycological Herbarium, Institute of Microbiology, Guangdong Province, China).

The macroscopic descriptions are based on field notes or dry preserved specimens where no field notes accompany the specimen. Microscopic examinations and measurements of hyphae, basidia and spores were made from freehand sections mounted in 5–10% KOH, 1% congo red and Melzer's reagent.

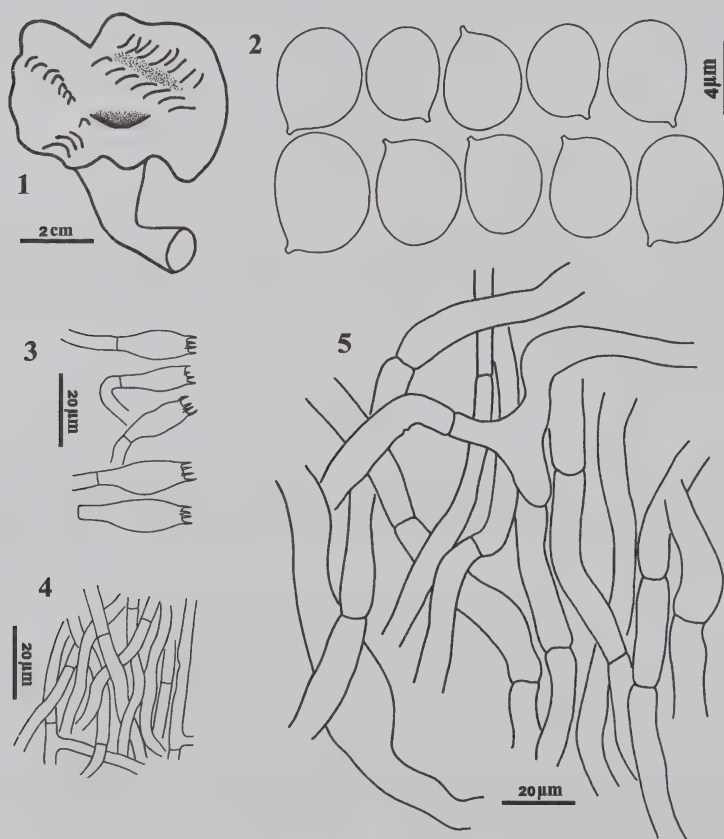
* corresponding author

Dimensions for basidiospores are given using notation of form (a–) b–c (–d). The range b–c contains a minimum of 90% of the measured values. Extreme values—e.g., a or d—are given in parentheses. Q is used mean ‘length/width ratio’ of basidiospores in side view, **Q** (in bold face) means average Q of all basidiospores measured $\pm$ sample standard deviation (Yang & Zhang 2003).

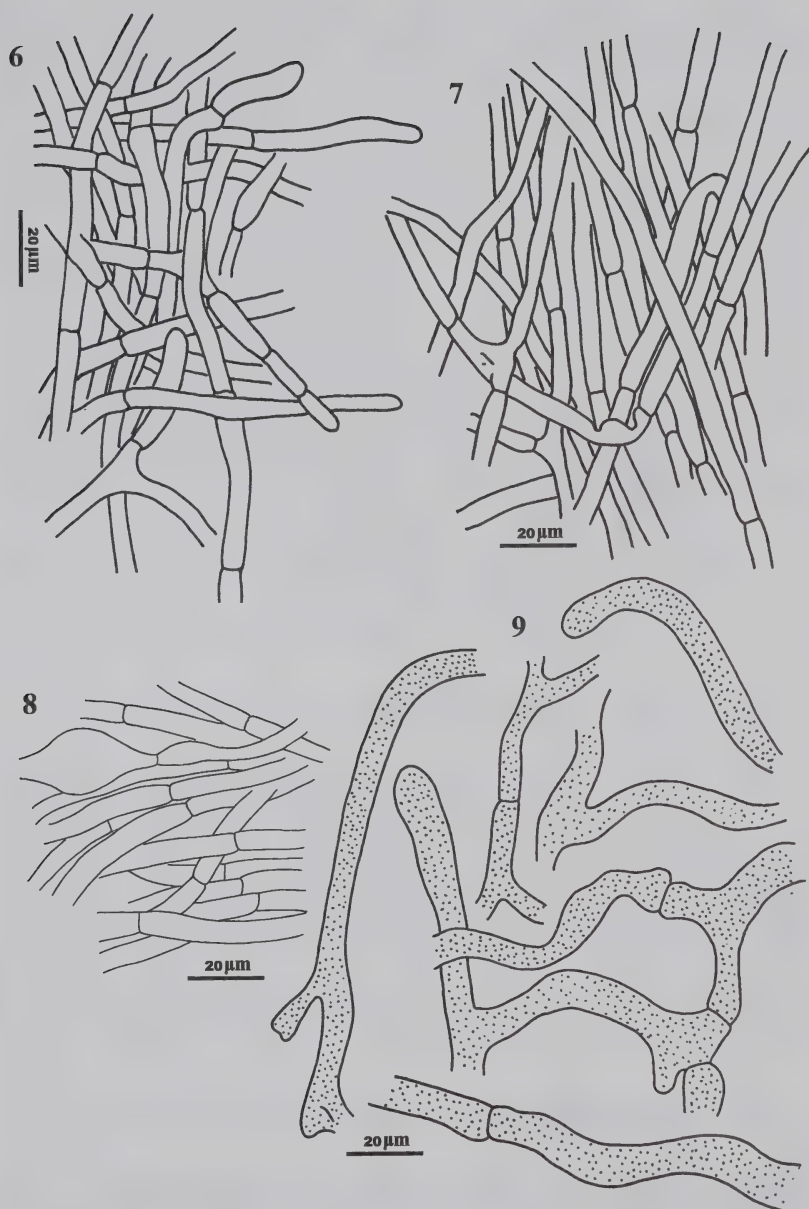
Taxonomic Descriptions

1. *Albatrellus henanensis* J.D. Zhao & X.Q. Zhang, Acta Mycologica Sinica 10 (4): 266, 1991 **Figs. 1–9**

Basidiocarp medium size, solitary (Fig.1). **Pileus** about 6.5 cm diam, uneven, pale yellow, grayish yellow to brownish orange, partly with greenish tint, azonate, nearly glabrous or with very fine scales, convex; margin thin, involuted, lobed, concolorous with the disc. **Stipe** lateral, bulbous at the base, 3cm long, 0.7 cm at apex and 1.5



Figs. 1–5: *Albatrellus henanensis* (HMAS 53936, holotype)
1. basidiocarp; 2. spores; 3. basidia; 4. tramal hyphae; 5. contextual hyphae



Figs. 6-9: *Albatrellus henanensis* (HMAS 53936, holotype)

6. pileipellis hyphae; 7. hyphae of stipe base;

8. hyphae of stipe surface; 9. gloeoplerous hyphae

cm thick at base, brownish orange, slightly darker than pileus; apex covered by the decurrent tubes; base covered by soft tissue; soft tissue grayish yellow or with light greenish tint. **Tube layer** decurrent, 1–2 mm thick, grayish orange, pore surface concolorous; pores circular, angular or irregular, 2–3/mm, dissepiments complete or dentate. **Context** concolorous with tube layer, soft, 2 mm thick.

Hyphal system monomitic. Tramal hyphae (Fig.4) hyaline or with very light yellowish tint in KOH, parallel, 2–6 μm diam, simple-septate, most hyaline, thin-walled, rarely with slightly thickened and very weakly amyloid hyphal walls. Contextual hyphae (Fig.5) light yellow in KOH, simple-septate, non-amyloid, thin- to moderately thick-walled, variable in diameter, mostly 5–10 μm diam, some inflated up to 20 μm diam. Pileipellis hyphae (Fig.6) cylindrical, with clavate or finger-shape tips, slightly thick-walled, walls mostly 0.5 μm thick, amyloid. Hyphae composing the greenish yellow soft tissue of the stipe base (Fig.7) light yellowish green in KOH, parallel and somewhat interwoven, 3–8 μm diam, thin- to slightly thick-walled, walls 0.5 μm thick, non-amyloid. Hyphae of the stipe surface (Fig.8) parallel, thin- to thick-walled. Gloeoplerous hyphae (Fig.9) present in trama and context, long, thin-walled, with branching, most 4–10 μm diam, some inflated to 18 μm diam.

Basidiospores (Fig.2) 5–5.8(-6) $\times$ 4–5 μm ($n = 60$, one basidiocarp) [$Q = (1.13\text{--}) 1.15\text{--}1.36(-1.45)$, $Q = 1.23 \pm 0.06$], broadly ellipsoid, hyaline, smooth, thin-walled, with a small but distinct apiculus, weakly amyloid.

Basidia (Fig.3) 17–28 $\times$ 6–8.5 μm , clavate, simple-septate at the base, 4-sterigmate, most 2.5–3 μm long, some up to 5 μm long.

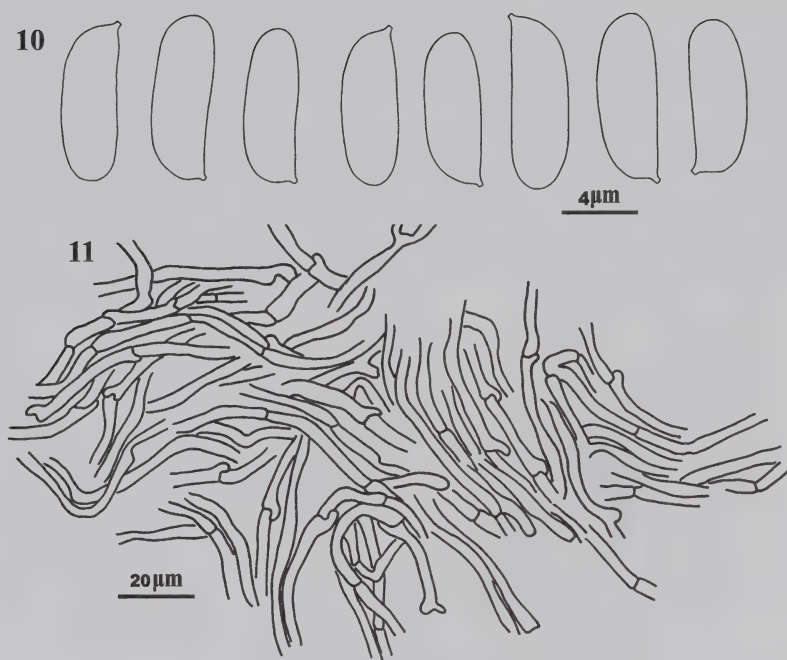
Specimen examined — CHINA, Henan Prov.: Lu Shi, July 1968, J-Z Ying et al. (HMAS 53936, holotype).

Remarks—Brownish to yellowish green pileus, orangish pore surface and tuber layer on dried specimens, generative hyphae simple-septate, basidiospores 5–5.8 (-6.0) $\times$ 4–5 μm , weakly amyloid are all the characters of the holotype of *A. henanensis* and they agree with descriptions of *A. cristatus* (Schaeff.) Kotl. & Pouzar (Gilbertson & Ryvarden 1986, Núñez & Ryvarden 2001). Therefore the name *A. henanensis* is placed in synonymy with *A. cristatus*. *A. henanensis* was listed as a synonym of *A. tianschanicus* (Bondartsev) Pouzar (Núñez & Ryvarden 2001). However, there are some differences between these two species. *A. tianschanicus* is distinguished from *A. henanensis* by its light brown and distinctly squamulose pilei, apricot to buff stipe with black base and distinctly amyloid basidiospores.

2. *Albatrellus jianfenglingensis* G.Y. Zheng, Acta Mycologica Sinica 11 (2): 108, 1992

Figs. 10–12

Basidiocarp annual, stipitate, growing on dead wood in cluster (see Zheng et al. 1992). **Pileus** white when fresh, yellowish in dry specimens, circular, depressed to shallow infundibuliform. 2–6.5 cm diam, glabrous, margin thin. **Stipe** central or eccentric, concolorous with pileus, slightly enlarged towards pileus, 1–3.5 $\times$ 0.2–0.4 cm, without black cuticle. **Tube layer** whitish, drying pale yellowish with grayish tints, pores



Figs. 10-11: *Albatrellus jianfenglingensis* (HMIGD 14403, holotype)
10. spores; 11. tramal hyphae;

angular, entire or slightly dentate, concolorous with tube layer, small, 6–7/mm when dried. **Context** 1–3 mm thick, white, becoming pale orange after drying.

Hyphal system dimitic. Tramal generative hyphae (Fig.11) hyaline in KOH, parallel, 2–5 μm diam, with numerous clamps and occasional simple septa, thin-walled. Contextual binding hyphae (Fig.12) thick-walled, non-septate, branched, with tapering apices, 3–15 μm diam.

Basidiospores (Fig.10) (7-)7.2–9(-9.5) $\times$ 2.8–3.3(-3.6) μm ($n = 90$, 30 spores measured from three basidiocarps of HMIGD 14403) [$Q = (2.14\text{--})2.33\text{--}3(-3.17)$, $Q = 2.7 \pm 0.21$], cylindrical, smooth, non-amyloid.

Specimen examined – CHINA, Hainan province, Ledong county: Jianfeng Ling, alt. 900–950 m, 15 May 1988, G.Y. Zheng et al. (HMIGD 14403, holotype).

Remarks—The holotype of *A. jianfenglingensis* (HMIGD 14403) represents a member of the genus *Polyporus* Fr. s. str. due to its cylindrical basidiospores and contextual binding hyphae. However, it is very special by its white color, stipe without black cuticle and small pores. There is no proper name for this specimen in the genus. So the new combination *Polyporus jianfenglingensis* (G.Y. Zheng) H.D. Zheng & P.G. Liu **comb. nov.** is proposed here.

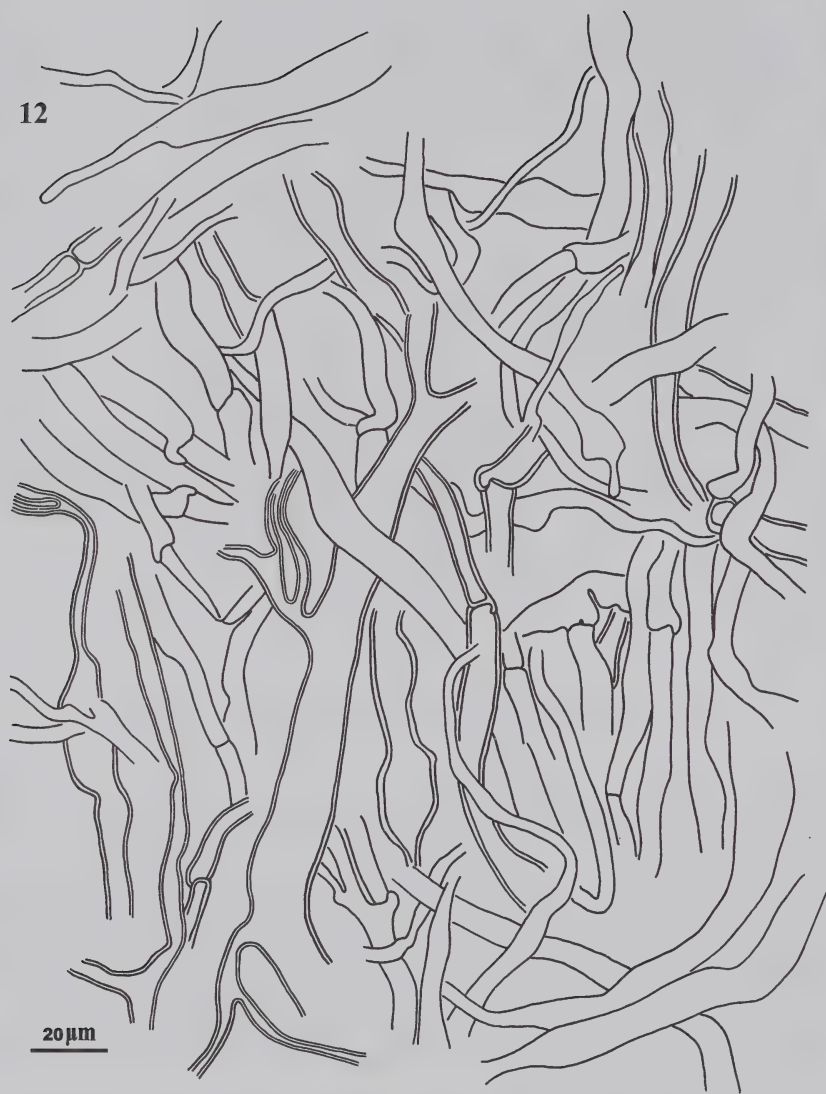


Fig. 12: *Albatrellus jianfenglingensis* (HMIGD 14403, holotype)
12. contextual binding and generative hyphae

Acknowledgements

The authors would like to thank the curators of Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (HMAS) and Mycological Herbarium, Institute of Microbiology, Guangdong Province, China (HMIGD) for the loan of specimens of the genus *Albatrellus*. Also thanks are expressed to Dr. James H. Ginns, Penticton, British Columbia, Canada and Gregory Mueller, Department of Botany, Field Museum of Natural History in Chicago, IL USA for their critical reviews, and for their invaluable comments and suggestions on this manuscript. The study was supported in part by grant from the National Science Foundation of China (No. 30470011), the Knowledge Innovation Program of the Chinese Academy of Sciences project grant (No. KSCX2-SW-101C; KSCX2-1-09-06) and the Natural Science Foundation of Yunnan Province (No. 2004C0050M).

Literature Cited

- Gilbertson RL, Ryvarden L. 1986. North American Polypores. Vol.1. Oslo: Fungiflora, Norway. 433pp
- Núñez M, Ryvarden L. 2001. East Asian Polypores. Vol.2. Oslo: Fungiflora, Norway. 512pp
- Yang ZL, Zhang LF. 2003. Type studies on *Clitocybe macrospora* and *Xerula furfuraceae* var. *bispora*. Mycotaxon 88: 447-454
- Zhao JD, Zhang XQ. 1991. Four new species of *Polyporaceae* in China. Acta Mycologica Sinica 10(4): 266-272
- Zheng GY, Zhang WM, Li TH & Lai JP. 1992. The genus *Albatrellus* of Guangdong and Hainan Provinces. Acta Mycologica Sinica 11(2): 107-110

河南地花菌和尖峰岭地花菌的模式研究

郑焕娣

中国科学院昆明植物研究所 昆明 650204;
中国科学院研究生院 北京 100039

刘培贵

中国科学院昆明植物研究所 昆明 650204

摘要: 通过对河南地花菌 (*Albatrellus henanensis* J.D. Zhao & X.Q. Zhang) 和尖峰岭地花菌 (*A. jianfenglingensis* G.Y. Zheng) 主模式的细致研究, 河南地花菌被作为毛地花 (*A. cristatus* (Schaeff.) Kotl. & Pouzar) 的异名处理, 尖峰岭地花菌被放在了多孔菌属 (*Polyporus* Fr. s. str.) 中, 成立了一个新组合, *Polyporus jianfenglingensis* (G.Y. Zheng) H.D. Zheng & P.G. Liu.

关键词: 地花菌科, 分类学, 中国

First record of *Leptosphaeria raphani* on *Draba aspera* found on the Balkan Peninsula

JELENA VUKOJEVIĆ, MILICA LJALJEVIĆ GRBIĆ,
BRANKA STEVANOVIĆ & VLADIMIR STEVANOVIĆ

vjelena@bfbot.bg.ac.yu

*Institute of Botany and Botanical Garden "Jevremovac", Faculty of Biology
University of Belgrade, Takovska 43,
11000 Belgrade, Serbia and Montenegro*

Abstract—*Draba aspera*, collected in Mt. Prokletije (Dinaride, Apennines and Dinaric Alps) was found as a new host of *Leptosphaeria raphani*. Differences between *L. raphani* in Serbia and other previously described isolates are discussed.

Key words—Ascomycotina, *Leptosphaeriaceae*, taxonomy

Introduction

The genus *Leptosphaeria* was established by Cesati and De Notaris (1863) and included 26 species. In the past 65 years, there have been a large number of intergeneric transfers of *Leptosphaeria* species. The original description of *Leptosphaeria* by Crane and Shearer (1991) is based on: host, structure of pseudothecium, ascospore septation, and presence of pseudoparaphyses or paraphyses. The same authors by using modern concepts and techniques for classification of *Leptosphaeria* listed 1689 taxa.

Hawksworth and Sivanesan (1975) described *Leptosphaeria raphani* on dead culms of *Raphanus maritimus* Sm. in Great Britain.

Material and methods

Field samples of *Draba aspera* were collected at Maja Kolata, 2530 m a.s.l., at Mountain Prokletije, Serbia and Montenegro, Balkan Peninsula, southeast Europe. Infected leaves were selected from the collected plant material and ascomata were separated for microscopic studies. Ascomata were mounted in water, lactofenol or acid fuchsin. At least one hundred ascomata, asci and ascospores were measured. Reproductive structures were drawn and photographed using a microscope Reichert-DIASTAR (Germany).

Description and remarks

Leptosphaeria raphani D. Hawksw. & Sivan., Trans. Br. Mycol. Soc. 64: 104, 1975.

Ascomarps (pseudothecia) visible externally as scattered black spots at the margin of the leaves, solitaires or arranged in groups, at first immersed, soon becoming superficial,

intermingled with the plant hairs, subglobose or globose, rarely conoid, black, 164-230 μm wide and 130-225 μm high, with thick papillate ostiole. Peridium wall with an external layer of textura angularis, brown, completely occluded by the melanin deposits. *Pseudoparaphyses* numerous, filiform, hyaline, septate, 400 μm long and about 1.5 μm wide. *Asci* numerous, 75.0-95.0 $\times$ 8.7-12.5 μm , clavate, short-stalked, bitunicate, 8-spores. *Ascospores* fusiform, 17.5-23.7 $\times$ 5.0-7.5 μm , 3 septate, with acute to rounded apices, second cell from apex sometimes slightly swollen, yellowish brown, overlapping biserial in the ascus (Figs. 1-4).

Host species: *Draba aspera* Bertol.

Specimens examined: Montenegro, Maja Kolata (Mauntain Prokletije), 2530 m a.s.l., on leaves of *Draba aspera*, 5 July 1995, Stevanović, V., Lakušić, D., Niketić, M., Bulić, Z., Hadžiablahović, S. 751/95 (BEOU! – Botanical Institute and Garden, Faculty of Biology, University of Belgrade).

Discussion

According to Crane and Shearer (1991), *Leptosphaeria raphani* was reported in Europe on *Raphanus maritimus* in Great Britain. Our results represent the first occurrence of *L. raphani* on Balkan Peninsula on the new host, *Draba aspera*.

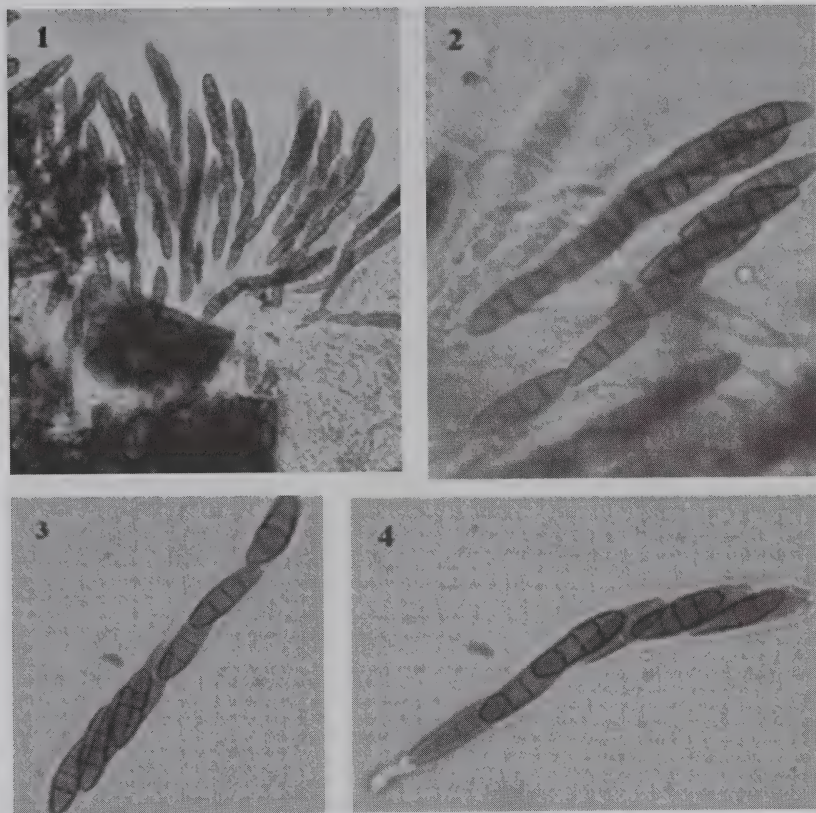
Shoemaker (1984), after the revision of *Leptosphaeria* collections in the National Mycological Herbarium Canada, (DAOM), renamed two previously described specimens of *L. johansonii* E. Müll. on *Arabis alpina* L. and on *Draba oblongata* R. Br. ex DC., as *L. raphani*. However, Canadian materials were not compared with an authentic material and therefore the revision of Shoemaker is provisional, which was also emphasized by him.

There are no considerably morphological differences between the reproductive structures of our isolates and the holotype except in their dimensions which can be a result of development on different hosts and in different environmental conditions (Table 1).

Table 1. Dimensions of the reproductive structures of different isolates of *Leptosphaeria raphani* (in μm).

	Hawksworth & Sivanesan (1975)	Shoemaker (1984)	Our results
Host	<i>Raphanus maritimus</i>	<i>Arabis alpina</i> <i>Draba oblongata</i>	<i>Draba aspera</i>
Ascomata	275-325 $\times$ 200-250	200-280 $\times$ 200-280	164-230 $\times$ 130-225
Asci	70.0-85.0 $\times$ 5.0-9.0	60.0-80.0 $\times$ 8.0-11.0	75.0-95.0 $\times$ 8.7-12.5
Ascospores	20.0-26.0 $\times$ 4.0-5.0	15.0-20.0 $\times$ 4.5-5.0	17.5-23.7 $\times$ 5.0-7.5

Leptosphaeria raphani has some similarities (form and ascospore septation) with *L. viridella* (Peck) Sacc., while it is significantly different from *L. maculans* (Desm.) Ces. & De Not., especially in septate number of ascospores, that is in accordance with results of Hawksworth and Sivanesan (1975).



Figs 1-4. *Leptosphaeria raphani*: 1. ascomata, 2. asci, 3-4. bitunicate asci with short stalk.

The hosts of *L. raphani* are *R. maritimus*, *A. alpina*, *D. oblongata* and *D. aspera* belong to *Brassicaceae* family, but they are phylogenetically distinctive. Thus, *R. maritimus* belongs to the tribe *Brassiceae*, *A. alpina* to *Arabideae*, and *Draba* species (*D. oblongata* and *D. aspera*) to *Alysseae*. Although these *Draba* species are closely related, they belong to different sections, *Chrysodraba* and *Aizopsis*, respectively (Schulz, 1936).

Pleospora pyrenaica Niessl, which is taxonomically close to the genus *Leptosphaeria* (ordo Pleosporales), was found on the same field samples of *D. aspera* collected from the same locality (Vukojević et al., 2000). *Draba aspera* is found to be a new host both for *L. raphani* and *P. pyrenaica*.

Acknowledgements

The authors would like to thank Dr André Aptroot (Institute of the Royal Netherlands Academy of Arts and Sciences, Centraalbureau voor Schimmelcultures, Baarn, The Netherlands) for verification of identification. We are thankful to Dr. Isabella Grishkan and Dr. Vladimir Vujanović for useful comments and review of the manuscript

References

- Cesati V, De Notaris G. 1863. Schema di Classificazione degli Sferiacei Italici Aschigeri più o meno appartenenti al genere *Sphaeria* nell' antico significato attribuitogli da Persoon. Commentario della Società Crittogamologica Italiana 1: 177-240.
- Crane JL, Shearer CA. 1991. A nomenclator of *Leptosphaeria* V. Cesati & de Notaris. Illinois Natural History Survey Bulletin 34(3): 1-355.
- Hawksworth DL, Sivanesan A. 1975. New and interesting microfungi from Slapton, south Devonshire: Ascomycotina. Transactions British Mycological Society 64(1): 101-111.
- Schulz DE. 1936. *Cruciferae*. Nat. Pflanzenfam 178: 227-656.
- Shoemaker RA. 1984. Canadian and some extralimital *Leptosphaeria* species. Canadian Journal of Botany 62: 2688-2729.
- Vukojević J, Ljaljević-Grbić M, Duletić-Laušević S. 2000. *Pleospora pyrenaica* on *Draba aspera* recently found in Yugoslavia. Mycotaxon 75: 389-393.

Myxomycetes of the Western Black Sea Region of TurkeyC. CEM ERGÜL¹, BAŞARAN DÜLGER², R. BATUR ORAN¹ & HASAN AKGÜL¹

ergulc@uludag.edu.tr

¹Uludag University, Faculty of Arts and Sciences
16059, BURSA-TURKEY²Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences
17100, ÇANAKKALE- TURKEY

Abstract—The distribution and abundance of myxomycetes in parts of the western Black Sea Region of Turkey during 2000–2002 are documented. Seventy-eight species belonging to 25 genera were recorded from field and moist chamber collections. *Badhamia goniospora*, *B. papaveracea*, *B. populina*, *Cribraria confusa*, *Dianema harveyi*, *Diderma niveum*, *Didymium sturgisii*, *Licea scyphoides*, *Macbrideola dubia*, and *Physarum globuliferum* are new for Turkey. Climograph and the checklist are available at the website http://biyoloji.uludag.edu.tr/ergul/Checklist_002.pdf.

Key words—slime moulds, new records, flora

Introduction

Turkey, which is located in between 36°–42° north latitude and 26°–45° east longitude, belongs to the Palearctic Biogeographical Realm (Olson & Dinerstein 2002) of the northern hemisphere. The present study was conducted in the Euxine province of the Euro-Siberian floristic region. This phytogeographical region covers an area of 130 000 km², nearly 15% of the total area of Turkey, and represents some of the most diverse and distinctive temperate forests in Eurasia (Kutluk & Aytuğ 2001, Olson & Dinerstein 2002). Turkey is influenced by a continental oceanic and mediterranean climate (Akman & Ketenoğlu 1986). The oceanic climate prevails on the northern slopes along the 1500 km Turkish Black Sea coast, but at some points along this coastal belt, especially the southern slopes, a Mediterranean climatic influence is apparent. In the Euxine vegetation areas there is no marked summer drought. High levels of precipitation and moderate temperature have been recorded during the summer months in some cities of the region (Atalay 2002). This area has a variety of special habitats, diverse microclimatic conditions and also includes internationally recognized natural reserves. The Kastamonu-Bartın Küre Mountains, which are protected as a national park, constitute 25% of the forest area of Turkey and are considered to be one of the Conservation International Global Biodiversity Hot Spots. The mountains have been included among 100 hot spots in Europe by the World Wildlife Fund. The Kastamonu-Ilgaz Mts. National Park, the Bolu-Abant Nature Park, and the Bolu-Seven Lakes National Park are also located in this part of Turkey. The forest vegetation of the study



Figure 1. The Western Black Sea Region and selected collecting sites.

area is dominated by the broad-leaved *Fagus orientalis*, *Quercus* spp., *Castanea sativa*, *Carpinus orientalis*, and *C. betulus* in addition to the conifers *Abies bornmuelleriana* and *Pinus* spp. (Akman 1995). In humid stream valleys *Platanus orientalis* and *Salix* spp. are the dominant tree elements. On rural land near the main roadsides illegal agricultural development has resulted in the loss of native vegetation and its replacement with an invasive secondary vegetation that includes *Juglans regia*, *Malus* spp., *Morus* spp., *Populus* spp., and *Sorbus* spp. Several new myxomycete taxa were identified in previous studies carried out on the western part of the region. Based on these previously published records 20 taxa have been identified as new records for Turkey.

Results

Incubating detrital material in Petri dish moist chambers and collecting sporocarps directly, we identified 78 taxa in the study area. The moist chamber technique yielded the greatest number of samples, 212, whereas only 43 specimens were found sporulating in the field. In total the collections were distributed among 25 genera. Representatives of all known orders of Myxomycetes were found. The *Physarales* was the best represented with 23 species, followed by the *Liceales* (19 species). The most abundant genera were in *Licea* (9 species), *Badhamia* (8), and *Stemonitis* (7). Each of the following genera was represented with 5 species: *Arcyria*, *Cribraria*, *Macbrideola*, *Physarum*. *Diderma*, *Didymium*, and *Perichaena* were represented by 4 species. Three species were found for each of *Echinostelium*, *Trichia*, and *Comatricha*, *Hemitrichia* and *Lycogala* were represented by 2 species each. Only a single species per genus was found for *Badhamiopsis*, *Ceratiomyxa*, *Clastoderma*, *Collaria*, *Dianema*, *Fuligo*, *Lindbladia*, *Reticularia*, *Stemonitopsis*, and *Tubilifera*. The most commonly found species were *A. cinerea*, *Macbrideola cornea*, *Physarum auriscalpium* and *Perichaena corticalis*. While only one sample of *A. cinerea* was found sporulating in nature, fourteen specimens were recovered in moist chambers. All 32 specimens of *Macbrideola cornea* and all 17 of *Physarum auriscalpium* were recovered in moist chambers. *Perichaena corticalis* was represented by 13 specimens, all of which were also recovered in moist chambers.

This high incidence of recovery demonstrates the high germination potential and wide dispersal of the spores of these species in the study region. The forty-three samples collected directly from natural habitat were distributed among 14 genera: *Stemonitis* (7 species), *Arcyria* (5), *Physarum*, *Lycogala* (each with 2), *Badhamia*, *Ceratiomyxa*, *Diderma*, *Didymium*, *Fuligo*, *Hemitrichia*, *Lindbladia*, *Reticularia*, *Stemonitopsis*, and *Tubulifera* (each with 1 species). When the distribution of species was analyzed, it was seen that the most of the *Stemonitis* species sporulating in nature were typically lignicolous; they were found on wood in riparian sites where the wood was decaying and soggy. Some of the other natural specimens and the species that were recovered in moist chambers, were either typically lignicolous or corticolous. The following species were recorded for the first time from Turkey: *Badhamia goniospora*, *B. papaveracea*, *B. populina*, *Cribraria confusa*, *Dianema harveyi*, *Diderma niveum*, *Didymium sturgisii*, *Licea scyphoides*, *Macbrideola dubia*, and *Physarum globuliferum*.

Discussion

The study area was rich in myxomycetes. Previously published studies recorded 20 taxa for the first time in Turkey. According to Lado (1993) the Mediterranean region allows for the development of one of the richest myxomycete biotas in the world. At present 78 species of myxomycetes are recorded from the Anatolian temperate forest ecoregion of the Palearctic biome. Future field work in early spring and late fall is likely to increase the number of myxomycete records for the area and also will reveal species that are new to science (Eliasson et al. 1988). According to Stephenson (1988), most studies dealing with the distribution and ecology of myxomycetes in terrestrial ecosystems have been conducted in temperate forests where these organisms are particularly abundant. Factors that appear to most strongly influence the seasonal production of sporocarps in forests are moisture and the availability of nutrients. Sporocarps generally are scarce during periods of drought, and are often produced two to three weeks after a heavy rainfall (Moore 1996). Diversity of ecological conditions and a wide diversity of substrata found in floristically diverse regions create excellent conditions for rich myxomycete productivity (Eliasson et al. 1988). Bark of *Quercus* species is more productive of myxomycetes (54 specimens) than is the bark of *Salix* spp. (33) and other trees, including *Platanus orientalis* (24), *Malus* spp. (22), *Pyrus* spp. (22), *Populus* spp. (20 specimens), *Creatagus* spp. (10), *Fagus orientalis*, *Abies bornmuelleriana* (8). The appearance of minor myxomycetes on the other vegetation elements of the study region were: *Sorbus* spp. (5 specimens), *Fraxinus* spp., *Pistacia* spp. (4 each), *Castanea sativa*, *Juglans regia*, *Morus* spp., *Robinia* spp. (3 each), *Carpinus* spp. *Vitis* spp. (2 each) and *Ulmus* spp. (1 specimen). The occurrence of different numbers of myxomycete collections on bark of different trees might relate primarily to the bark textures. The deeply furrowed bark of *Quercus* spp., *Salix* spp. and *Platanus* spp. tends to accumulate water and nutritive soil particles essential proliferation of myxomycetes. According to McHugh (1998) and Lado (1993), individual *Quercus* spp and *Quercus* forests are the most productive sources for myxomycetes. Nutrients most likely to influence sporocarp production in nature (Moore 1996). Although *Salix*, *Malus*, *Pyrus* and *Populus* are not native, they provide new substrata for the development of myxomycetes, thus providing the potential for increasing the diversity of myxomycetes

in the region. Ukkola & Rikkinen (2000) noted the increase in myxomycete diversity with an increase in heterogeneity of substratum types, especially in relation to an increase in the availability of angiosperm bark and wood.

Acknowledgments

This research was supported by Uludag University Research Found (Project No: 2000/14). We are thankful to Dr. Gary Samuels (USDA-ARS, Systematic Botany and Mycology Lab, U.S.A.) and Dr. S.L. Stephenson (Univ. of Arkansas, U.S.A.) for their contributions to this manuscript. We also thank Dr. M. Schnittler (EMUA Griefswald Bot. Inst., Germany) for his helpful comments.

References

- Akman Y. 1995. Türkiye Orman Vegetasyonu, Ankara Üniversitesi Fen Fakültesi, Ankara
- Akman Y, Ketenoglu O. 1986. The climate and vegetation of Turkey. Proceedings of the Royal Society of Edinburgh 89B:123-134.
- Atalay İ. 2002. Türkiye'nin Ekolojik Bölgeleri (Ecoregions of Turkey), Orman Bakanlığı Yayınları No:163, Meta Basımevi, İzmir.
- Eliasson.U.H, H.W.Keller, and J.A.Hutchinson.1988. Myxomycetes from Arkansas. Mycotaxon 32:375-398.
- Kutluk H, Aytuğ B. 2001.Davis' Flora of Turkey. Proc. Second Balkan Bot. Congr. 1:289-294
- Lado C. 1993. Myxomycetes of Mediterranean woodlands. In:Pegler D.N, Baddy L., Ing B., Kirk P.M.(eds.):Fungi of Europe: Investigation, recording and conservation. Royal Botanical Garden: Kew (England).93-114.
- Lado C. 2001. Nomenmyx. Caudernos De Trabaja De Flora Micologica Iberica 16. Consejo Superior De Investigaciones Cientificas Real Jardin Botanico: Madrid (Spain). 219pp.
- McHugh R. 1998. Corticolous Myxomycete from Glen Mhuire, Co. Wicklow. Mycologist 12:166-168.
- Moore-Landecker E. 1996. Fundamentals of the Fungi. Prentice Hall. NJ. 574pp.
- Olson DM, Dinerstein E. 2002.The Global 200:Priority Ecoregions for Global Conservation. Ann. Missouri Bot. Gard. 89:199-224.
- Stephenson 1988. Distribution and ecology of myxomycete in temperate forests. II. Patterns of occurrence on bark surface of living trees,leaf litter, and dung. Mycologia 81: 608-621.
- Ukkola T, Rikkinen J. 2000. Myxomycetes in the forests and woodlands of Western Oregon. Mycotaxon 76: 213-245.

A new *Lepraria* species from Gough Island, South Atlantic Ocean

JOHN A. ELIX

John.Elix@anu.edu.au

Department of Chemistry, Faculty of Science, Australian National University
Canberra, A.C.T. 0200, Australia

DAG OLAV ØVSTEDAL

dag.ovstedal@bot.uib.no

Botanical Institute, University of Bergen, Allégaten 41, N - 5007 Bergen, Norway

NIEK J. M. GREMMEN

gremmen@wxs.nl

Unit of Polar Ecology, Limnology and Paleobiology, University of Antwerpen,
Belgium & Data Analyse Ecologie, Hesselsstraat 11, 7981 CD Diever,
The Netherlands

Abstract—*Lepraria goughensis* from Gough Island is described as new to science. It is the first species of *Lepraria* known to contain a combination of lecanoric acid, gyrophoric acid, stepsilin, fragilin and 7-chloroemodin.

Key words—lichens, taxonomy

Introduction

Gough Island (40°21' S, 9°53' W) is an uninhabited cool-temperate oceanic island, situated in the South Atlantic Ocean, approximately midway between the southern tip of Africa and South America. It is part of the Tristan-Gough group of islands, and is approximately 300 km removed from the other islands of this group. The island measures *ca.* 6 km by 14 km and is mountainous. The highest peak reaches 910 m above sea level, and much of the island is above 400 m. The island is of volcanic origin, but shows no sign of recent volcanic activity. The climate is cool and wet, with a mean temperature at sea level of *ca.* 11° C, a mean annual precipitation in excess of 3000 mm, and with frequent gale-force winds. So far approximately 100 lichen species have been recorded (Elix & Gremmen 2002, Øvstedal & Gremmen in prep.), and these range from tropical to temperate in origin. During the study of the lichens from this island, some specimens of an unknown *Lepraria* species were discovered, and it is described here.

Materials and Methods

The specimens studied are deposited in BG. The morphology of the lichen specimens were examined using a Zeiss Stemi 2000C stereo microscope, and a Zeiss Axiolab compound microscope. Chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson et al. 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Taxonomic Description

Lepraria goughensis Elix & Øvstedal, sp. nov.

Thallus leprosus, 1-4 cm latus, griseo-viridis, acidi lecanorica, gyrophorica, strepsilin, fragilin, 7-chloroemodin, et flavo-obscurin C continens.

Etymology: The specific epithet derives from the Latin *ensis* (place of origin) and Gough Island.

Type here designated: **GOUGH ISLAND**. Seal Beach, 40°20'S, 9°52'W, over bryophytes and plant litter on vertical peat surface in shade, *N. Gremmen* 99-701, 22 Sept. 1999; holo: BG.

KEY CHARACTERS — **Thallus** crustose, entirely leprose, forming rosettes from 1-4 cm wide, thin, 0.2-0.3 mm thick, with a tendency to form poorly defined marginal lobes but with no medulla, upper surface grey-green. Soredia fine, 20-26 μ m wide, with numerous protruding hyphal ends. No hypothallus observed. **Chemistry** — K-, C+ red, KC+ red, P-; containing lecanoric acid (major), gyrophoric acid (minor), strepsilin (minor), fragilin (trace), 7-chloroemodin (trace), and flavo-obscurin C (trace).

Distribution — At present this species is only known from two localities on Gough Island.

Ecology — This species grows over bryophytes, plant litter or peat on steep slopes; in shady and humid places.

COMMENTS — The observed combination of secondary metabolites present in *L. goughensis*, namely the lecanoric acid - gyrophoric acid complex, a dibenzofuran and anthraquinones, is unique in the genus *Lepraria*. Two other *Lepraria* species contain lecanoric acid as the major component, namely *L. atrotomentosa* Orange & Wolseley (Orange et al. 2001) and *L. lecanorica* Tønsberg (Tønsberg 2004). *Lepraria atrotomentosa* contains additional atranorin and zeorin, whereas *L. lecanorica* contains only additional atranorin. Both of these species lack gyrophoric acid, the anthraquinone pigments and dibenzofuran derivatives present in *L. goughensis*. Like *L. goughensis*, *L. atrotomentosa* has a thin thallus but differs morphologically in having a well-developed layer of dark blue-grey to dark brown hyphae on the lower side. Morphologically *L. lecanorica* differs from *L. goughensis* in having a thicker (0.6 mm cf. 0.2-0.3 mm thick) stratified thallus with a distinct medullary layer. The dibenzofuran strepsilin has recently been detected in *L. multiacida* Aptroot and *L. xerophila* Tønsberg (Elix & Tønsberg 2004; Tønsberg 2004), while anthraquinone derivatives have been found in *L. bergensis* Tønsberg, *L. sipmaniana* (Kümmerl. & Leuckert) Kukwa and a chemotype of *L. incana* (L.) Ach. (Tønsberg 2002).

SPECIMENS EXAMINED — **GOUGH ISLAND.** Seal Beach, 40°20'S, 9°52'W over plant litter, *N. Gremmen* 99-316, 12 Sept 1999; Seal Beach, 40°20'S, 9°52'W, over moss on wet, vertical slope, *N. Gremmen* 99-323, 13 Sept. 1999 (BG); Prion Cave, inland of Standoff Rock, 40°21'S, 9°53'W, on moss on vertical rockwall in *Phyllica* forest, *N. Gremmen* 2000-0456, 27 June 2000 (BG).

Acknowledgements

NJM Gremmen thanks the Tristan da Cunha Government for the opportunity to visit the island; James Glass, Tristan da Cunha Department of Natural Resources, and Peter Ryan, Gough Island Management Committee, for their support. Logistic support by the South African Department of Environmental Affairs and Tourism is gratefully acknowledged. We also thank our peer reviewers, Dr Alan W. Archer and Dr Patrick M. McCarthy, for helpful amendments to the draft manuscript.

Literature Cited

- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113-125.
- Culberson CF, Culberson WL, Johnson A. 1981. A standardized TLC analysis of β -orcinol depsidones. *Bryologist* 84: 16-29.
- Culberson CF, Johnson A. 1982. Substitution of methyl *tert*-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *Journal of Chromatography* 238: 483-487.
- Elix JA, Ernst-Russell KD. 1993. A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic relationships for Lichen Substances (2nd Edition). Australian National University, Canberra.
- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1-7.
- Elix, JA, Gremmen, NJM. 2002. The lichen family Parmeliaceae (Ascomycotina) on Gough Island, South Atlantic Ocean. *Mycotaxon* 81: 257-264.
- Elix, JA, Tønsberg, T. 2004. Notes on the chemistry of some lichens, including four species of *Lepraria*. *Graphis Scripta* 16: 43-45.
- Orange, A, Wolseley, P, Karunaratne, V, Bombuwala, K. 2001. Two leprarioid lichens new to Sri Lanka. *Bibliotheca Lichenologica* 78: 327-333.
- Tønsberg, T. 2002. Notes on non-corticolous *Lepraria* s. lat. in Norway. *Graphis Scripta* 13: 45-51.
- Tønsberg, T. 2004. *Lepraria* In: Lichen Flora of the Greater Sonoran Desert Region (eds. TH Nash III, BD Ryan, P Diderich, C Greis & F Bungartz) *Lichens Unlimited*, Tempe, vol. 2: 322-329

Changes and additions to the checklist of North American Lichens — III

KERRY KNUDSEN

kk999@msn.com

*Herbarium, Botany & Plant Sciences Department
University of California, Riverside
Riverside, CA, 92521-0124, USA*

JAMES C. LENDEMER

lendemer@acnatsci.org

*Lichen Herbarium, Department of Botany
The Academy of Natural Sciences of Philadelphia
1900 Benjamin Franklin Pky., Philadelphia, PA, 19103, USA*

Abstract. – *Lecidea santae-monicae* and *Lecidea violascens* are placed in synonymy with *Lecidea laboriosa*. A new combination is made: *Polysporina oligospora*. *Ramonia gyalectiformis* is considered a species distinct from *R. ablephora*. *Sarcogyne plicata* (currently called *Biatorrella plicata*) is placed in synonymy with *Sarcogyne privigna*. A neotype is selected for *Sarcogyne novomexicana*. *Sarcogyne californica* is placed in synonymy with *Sarcogyne similis*. Lectotypes are selected for the following names: *Lecidea santae-monicae*, *Lecidea violascens*, *Sarcogyne californica*, and *Sarcogyne similis*.

1. *Lecidea laboriosa* Müll. Arg., Flora, 57: 187–188. 1874.

Syn nov. *Lecidea santae-monicae* H. Magn., Meddelander från Göteborgs Botaniska Trädgård, 10: 49. 1935. TYPE: Santa Monica Range, California, USA, 1909, *H.E. Hasse s.n. in* Hasse-Plitt exs. No. 62 as *Lecidea diducens* (S!, **lectotype, designated here**).

Syn nov. *Lecidea violascens* H. Magn., Meddelander från Göteborgs Botaniska Trädgård, 10: 48. 1935. TYPE: Santa Monica Range, California, USA., 1909, *H.E. Hasse s.n. in* Hasse-Plitt exs. No. 62 as *Lecidea diducens* (S!, **lectotype, designated here**).

In a continuing study of rare or missing species reported from the Santa Monica Mountains (Knudsen, 2005) the types were examined of two *Lecidea* species named by Magnusson from collections by H. E. Hasse. Magnusson's concept of *Lecidea santae-monicae* is known apparently from a single specimen in hb. Vrang (S) selected from the Hasse-Plitt exs. No. 62 of *Lecidea diducens*. Magnusson's concept of *Lecidea violascens* is known from two syntypes. The first syntype Magnusson selected from the

same Hasse-Plitt exs. No. 62 of *Lecidea diducens* which we select here as the lectotype. The remaining syntype was collected at Eden Hot Springs in Riverside County, California. The lectotypes of both names are on granitic rock which forms the basement rock of the east end of the Santa Monica Mountains, and is only exposed in areas of the range west of Mount Lee (on which the Hollywood sign is located) to Cahuenga Pass (Dibblee 1982).

Both lectotypes are *Lecidea laboriosa* (as described by Hertel and Prinzen 2004). This is the most common species of *Lecidea* in southern California and we have collected it from sandstone outcrops above the Pacific Ocean to high in the San Bernardino and San Jacinto Mountains. It is important to note that Magnusson (1935a) did not recognize *L. laboriosa* as occurring in America. An especially rich concentration of the melaenida-red pigment that often occurs in the exciple is all that really distinguishes *L. violascens* from an average specimen of *L. laboriosa* in southern California. *Lecidea santae-monicae* is an average specimen with a small concentration of melaenida-red pigment in the exciple. Magnusson recognized the species were very close to one another (1935a).

The Hasse-Plitt exsiccati No. 62 *Lecidea diducens*, in many herbaria, may contain *L. diducens*, *L. cinerata*, or *L. laboriosa* (with specimens not necessarily conforming to Magnusson's concepts of *L. santa-monicae* or *L. violascens*.)

2. *Polysporina oligospora* (H. Magn.) K. Knudsen, **comb. nov.**

Sarcogyne oligospora H. Magn., Acta Horti Gotoburgensis, 19(1): 32. 1952. TYPE: On dry exposed sandstone, Ekker's Ranch, Wayne Co., Utah, USA, 6000 ft., *S. Flowers* 372 (UPS!, holotype).

In the process of a study of *Polysporina* in the Sonoran area (Knudsen in prep.) number of specimens of *Polysporina cyclocarpa* (Anzi) Vězda were seen determined originally as *Sarcogyne oligospora*. *Polysporina oligospora* has smaller apothecia, 0.5-0.8 mm wide, 0.2-0.3 mm thick with ascospores 7-10 x 4-5 μm . No specimens have been seen other than the holotype.

3. *Ramonia ablephora* (Nyl.) R.C. Harris, Bryologist, 96(3): 474. 1993.

Lecidea ablephora Nyl. in Hasse, Lichens of Southern California, p. 15. 1898. TYPE: On clay, Santa Monica Mountains, California, USA. *H.E. Hasse s.n.* (NY!, lectotype).

Harris (1993) placed *Ramonia gyalectiformis* into synonymy with *R. ablephora* on the basis of the figures and description provided by Vězda (1967). When attempting to identify several collections recently made by the authors it was noticed that the published spore sizes for each species differed significantly. Comparison of the lectotype of *R. ablephora* with the recent collections confirmed that two species differing primarily in ascospore size and shape were involved. Further comparison with the data presented by Vězda (1967) lead to the discovery that the new collections represented *R. gyalectiformis*, a species distinct from *R. ablephora*. *Ramonia ablephora* is presently known only from the type collection and differs from the superficially similar *R. gyalectiformis* in having smaller ascomata and broadly ovate-fusiform ascospores, ca. 4-celled, 23-27 x 7-8 μm . It appears to be a narrow endemic of the Santa Monica Mountains.

4. *Ramonia gyalectiformis* (Zahlbr.) Vězda, Folia Geobot. & Phytotax., 2: 312. 1967.

Bilimbia gyalectiformis Zahlbr., Beihefte Bot. Centralbl., 13: 158. 1902. TYPE: "Ad terram nudam, Palm Springs in montibus San Jacinto", California, USA. H.E. Hasse 824 (W).

Bacidia gyalectiformis (Zahlbr.) Hasse, Contrib. U.S. Nat. Herb., 17(1): 50. 1913.

As is noted above *R. gyalectiformis* is not a synonym of *R. ablephora*. *R. gyalectiformis* is distinguished from the superficially similar *R. ablephora* by the larger ascomata and ca. 4-celled, fusiform ascospores, (17.5)-20-(25) x 5-6 μm . For a full description refer to Vězda (1967). Several recent collections are cited below. It should be noted that the type specimen could not be located at W (O. Breuss, pers. comm.). We presume it is still on loan and has not been lost. *Ramonia gyalectiformis* is only currently known from the San Jacinto Mountains from the two locations below and it may be a narrow endemic.

USA. CALIFORNIA. RIVERSIDE CO.: over steep rock outcrops of decomposing granite and sandstone on hillside, on edge of ravine with dry streambed, on the west side of Bautista Canyon Road, Bautista Canyon, elev. 795 m., 33° 39' 30" N, 116° 46' 20" W, Lendemer 2876 & Knudsen (hb. Lendemer); spike moss terraces with desert scrub, on a southwest facing slope, along the north side of CA Route #243, south fork of the San Jacinto River, San Jacinto Mountains, east of Hemet, elev. 857 m., 33° 42' 37" N, 116° 46' 23" W, Lendemer 2641 & Knudsen (hb. Lendemer), Lendemer 3772 & Knudsen (NY, UCR, hb. Lendemer).

6. *Sarcogyne novomexicana* H. Magn., Ann. Crypt. Exot., 7(3-4): 142. 1934.

TYPE: Las Vegas, Nevada, USA, 1927, Brouard No. 19.560 (hb. B. de Lesdain, holotype (destroyed)). NEOTYPE: On west-facing vertical surface of Hcl- boulders in mixed conifer forest, 34° 11' 78" N, 116° 46' 81" W, elev. 2568 meters, steep slope above Wildhorse Meadows, San Bernardino Mountains, San Bernardino County, California, USA. Knudsen 1601 & Wagner (UPS!, **neotype selected here**; ASU! MIN! UCR! hb. Lendemer, hb. McCune! duplicates of neotype [isoneotypes]).

Sarcogyne novomexicana was named from a single specimen collected by Brouard in Las Vegas, Nevada in 1927. The type of *S. novomexicana* was presumably destroyed with the herbarium of Bouly Lesdain in Dunkirk. Apparently Magnusson kept no duplicate or fragment. This species is one of the most beautiful *Sarcogyne* and has large reddish-brown discs that turn orange when wet, thick septate paraphyses, and broad spores. A full description will be provided by Knudsen & Standley (in prep.). It is apparently a rare species occurring above 1900 meters in New Mexico and southern California. The neotype is deposited at UPS in honor of Magnusson's contribution to lichenology.

7. *Sarcogyne privigna* (Ach.) A. Massal., Gener. Lich., p.10. 1854

Lecidea privigna Ach., Meth. Lich., p. 49.1803.

Biatorrella privigna (Ach.) Sandst., Flecht. Nordwdeutschen Tiefl., p. 138. 1912.

Syn nov. *Sarcogyne plicata* H. Magn., Ann. Crypt. Exot., 7(3-4): 134. 1934. TYPE: On plaster of a wall, Upland, California, USA. 17 February 1917. I. M. Johnstone (FH! holotype.)

Biatorrella plicata (H. Magn.) Zahlbr., Cat. Lich. Univ., 10: 418. 1939.

Sarcogyne plicata was based on two specimens from southern California (FH!). This is not a stable morphotype of *S. privigna*. Some of the apothecia are elongated and it has a thicker and more prominent parathecium which usually splits and curls obscuring the disc. The following specimens collected from above the type locality, which is now a suburb, are good examples of the *S. plicata* form intergrading with typical *S. privigna*.

USA. CALIFORNIA. SAN BERNARDINO CO.: On granite boulders in flood plain, San Antonio Wash behind San Antonio Dam, San Gabriel Mountains, elev. 761 m., 34° 10.537' N 117° 40.474' W, *Knudsen 1230, Knudsen 1231* (ASU, NY, MIN, UCR, hb. Ketzner, hb. Lendemer)

8. *Sarcogyne similis* H. Magn., Ann. Crypt. Exot., 7(3-4): p.135. 1934. TYPE: On sandstone, Devil's Cañon, Santa Cruz Mountains, California, USA. elev. 2300 ft. 8.August.1906. A.W.C.T. Herre 948 (FH!, **lectotype, designated here**).

Syn. nov. *Sarcogyne californica* H. Magn., Ann. Crypt. Exot., 7(3-4): 138. 1934. TYPE: Topanga Canyon, California, USA. 1908. H.E. Hasse 1102 (FH!, **lectotype, designated here**).

Sarcogyne similis occurs across North America on acid rocks and is particularly common in the west.

Sarcogyne californica is a synonym of *S. similis*, differing only in being described as always immarginate and pulvinate. The pulvinate form is caused by the multiple division of an apothecium and is very striking when seen but intermediates are numerous with the apothecium dividing into a lesser number of apothecia and being less convex to plane. Divisions forming pulvinate clusters were observed on hard granite boulders, which may stimulate it by restricting the spread of endolithic hyphae; on crumbling granite, sandstone, pebbles and small rocks, or on soil, convex and immarginate discs are usually rare.

Acknowledgements

We wish to thank the following for helpful discussion, commentary, and criticism: O. Breuss, F. Bungartz, I. Brodo, S. Eliason, R.C. Harris, K. Kramer, J. Tizler, C.M. Wetmore. We also to thank the curators of the following herbaria for the loan of material used in this study: FH, S, UPS.

Literature Cited

- Dibblee Jr, TW. 1982. Geology of the Santa Monica Mountains and Simi Hills, Southern California. in DL Fife, JA Minch. Geology and Mineral Wealth of the Transverse Ranges, 94-130.
- Knudsen K, Standley SM. [in prep] *Sarcogyne*. in Lichen Flora of the Greater Sonoran Desert Region, vol. 3.
- Knudsen K. [in prep.] *Polysporina*. in Lichen Flora of the Greater Sonoran Desert Region, vol. 3.
- Knudsen K 2005. Lichens of the Santa Monica Mountains, Part One. Opuscula Philolichenum, 2: 27-36.
- Magnusson AH. 1935a. On saxicolous species of the genus *Lecidea* proper to North America. Meddelander från Göteborgs Botaniska Trädgård, 10: 1-53.
- Magnusson AH. 1935b. On the species of *Biatorella* and *Sarcogyne* in America. Annales de Cryptogamie Exotique, 7: 115-146.

- Magnusson AH. 1952. New crustaceous lichen species from North America. Acta Horti Gotoburgensis, 19(1): 31-49.
- Hertel H, Printzen C. 2004. *Lecidea* in TH Nash III, BD Ryan, P Diederich, C Gries, F Bungartz (eds.): Lichen Flora of the Greater Sonoran Region 2: 287-309.
- Vězda A. 1967. Flechtensystematische Studien V. Die Gattung *Ramonia* Stiz. Zusätze. Folia Geobot. & Phytotax., 2: 311-317.

Taxonomic studies of *Alternaria* 9: two new species and two new records from China

XIA SUN, MENG ZHANG & TIAN-YU ZHANG*

sx-76@163.com

Department of Plant Pathology
Shandong Agricultural University
Taian, 271018 China

Abstract—Two new species, *Alternaria impatientis* on *Balsaminaceae*, *A. pharbitidicola* on *Convolvulaceae*, are described. *Alternaria impatientis* is large-spored species and is the first species described from the *Balsaminaceae*. *A. pharbitidicola* is characterized by producing single conidium with filiform and unbranched beak. *A. mouchaccaae* and *A. crotonicola* are reported as new records from China.

Key words—*Acalypha*, *Agropyron*, *Impatiens*, *Pharbitis*

Since the publication of *Flora Fungorum Sinicorum* Vol. 16: *Alternaria* (Zhang 2003), which includes 123 species, varieties and 2 forma speciales, a number of new taxa in the genus have been found from China. In this paper, two new species and two new records for China are reported.

Alternaria impatientis X. Sun & T.Y. Zhang, sp. nov.

Fig. 1

Maculae orbiculares vel suborbiculares, flavo-brunneae, 5-10 mm diam. concentricae zonatae. Caespituli amphigeni. Conidiophora solitaria vel fasciculata, erecta, recta vel curvata, non ramosa vel ramosa, septata, 76.5~115.5×4.5~6.0 µm. Conidia solitaria vel interdum 2 catenulata, obclavata, flavo-brunnea, 5-9 transverse septata, 1-4 longitudinaliter vel oblique septata, centro 1-2 septa incrassata. 49.5~72.0×14.0~22.0 µm (av. 59.8×17.9 µm). Rostra filiformia, infusca vel subhyalina, septata, 32.5~95.5 (~153.0)×2.0~3.0 µm (av. 73.8×2.6 µm).

Habitatio typi in foliis maculis Impatientis sp., Balsaminaceae, Mohe, Heilongjiang Provincia, 2003, Leg. T.Y. Zhang, HSAUP₀₃0148 (=ZTY₀₃0148).

Holotypus hic designatus: Specimen et pars ex cultura (isol. X. Sun, 2003) in PCA et in PCA-charta filtra desiccatae in HSAUP₀₃0148 (=ZTY₀₃0148) conservatae.

Leaf spots circular or subcircular with concentric rings, yellowish brown, 5-10 mm in diam. Fruiting amphigenous. Conidiophores solitary or fasciculate, simple or branched,

*Corresponding author: tyzhang@sdaa.edu.cn

erect, straight to curved, septate, light brown, $76.5\sim115.5\times4.5\sim6.0\mu\text{m}$. Conidia solitary or occasionally in chains of two, spore body obclavate, yellowish brown, with 5-9 transverse septa, 1-4 longitudinal or oblique septa, slightly constricted at septa, the central 1-2 septa occasionally thicker and darker than the others, $49.5\sim72.0\times14.0\sim22.0\mu\text{m}$ (av. $59.8\times17.9\mu\text{m}$). Rostra filiform, very pale brown or subhyaline, septate, $32.5\sim95.5$ (~153.0) $\times2.0\sim3.0\mu\text{m}$ (av. $73.8\times2.6\mu\text{m}$).

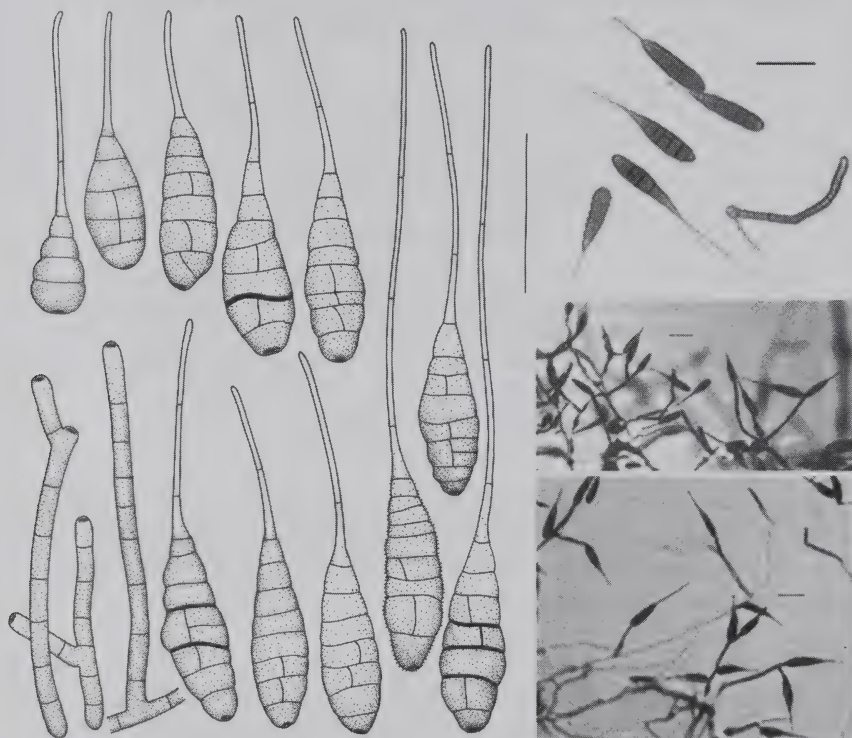


Fig.1 *Alternaria impatientis*. Left: Conidia and conidiophores ex natural substrate. Upper right: Conidia and conidiophores ex culture on PCA, Middle and lower right: Sporulation pattern (PCA 7d.). (All above ex HSAUP₀₃0148, Bars= $50\mu\text{m}$)

Colonies on PCA circular, effuse, pale brown, reaching about 7.0 cm diam. in 10 days at room temperature, a light red pigment often diffusing into the medium, sporulation sparse and mostly in the outer half of the colony, on PCA-filter paper, sporulation abundant. Conidia single or in chains of two, size and shape are similar in both the field type specimen and in PCA culture.

Holotype: on leaf spots of *Impatiens* sp., Mohe, Heilongjiang Province, 2003, Coll. T.Y. Zhang, HSAUP₀₃0148 (=ZTY₀₃0148). And dried ex-type cultures on PCA and PCA-filter paper in HSAUP₀₃0148.

This is the first report of an *Alternaria* species on a member of the *Balsaminaceae*.

***Alternaria pharbitidicola* X. Sun, Meng Zhang & T.Y. Zhang, sp. nov. Fig. 2**

Maculae suborbiculares, atro-brunneae, margine griseae, concentrice zonatae, 3-8mm diam. Caespituli imprimis epiphylli. Conidiophora solitaria vel fasciculata, brunnea, recta vel leviter curvata, non ramosa vel raro ramosa, septata, 62.5~109.5×6.0~8.0µm. Conidia solitaria, (raro 2 catenulata), brunnea vel atro-brunnea, obclavata vel obpyriformia, 6-10 transverse septata, 1-4 longitudinaliter vel oblique septata, constricta, 37.5~59.5×10.5~22.0µm (av. 48.9×14.2µm). Rostra filiformia, pallide brunnea vel subhyalina, septata, 65.5~234.0×2.0~3.0µm (av. 152.1×2.5µm).

Habitatio typi in foliis maculis Pharbitidis purpureae (L.) Voight, Dali, Yunnan Provincia, 2003, Leg. T.Y. Zhang, HSAUP₀₃0081 (=ZTY₀₃0081).

Holotypus hic designatus: Specimen et pars ex cultura (isol. X. Sun, 2003) in PCA et in PCA-charta filtra desiccata in HSAUP₀₃0081 conservata.

Leaf spots circular or subcircular, dark brown with greyish margin, usually 3-8 mm in diam. Fruiting mainly epiphyllous. Conidiophores solitary or fasciculate, rarely branched, straight or slightly curved, septate, brown, 62.5~109.5×6.0~8.0µm. Conidia solitary or occasionally in chains of two, brown or dark brown, obclavate or obpyriform, with 6-10 transverse septa, 1-4 longitudinal and oblique septa, constricted at septa, the central 1-2 septa often slightly darker than the others, 37.5~59.5×10.5~22.0µm (av. 48.9×14.2µm) excluding beaks; rostra filiform, up to 2-4 times the length of the spore body, very light brown or subhyaline, septate, 65.5~234.0×2.0~3.0µm (av. 152.1×2.5µm).

Colonies on PCA grow rapidly, attaining a diameter of about 8.3 cm in 10 days at room temperature, appearing circular, effuse, greyish brown. Sporulation on PCA moderate, mostly near the periphery of the colony. On PCA-filter paper, sporulation abundant, conidiophores straight or slightly curved, unbranched or occasionally branched. Conidia solitary or rarely in chains of two. Conidium body in culture (av. 60.0×19.0µm) is a little larger and darker than that in field specimen.

Holotype: HSAUP₀₃0081 (=ZTY₀₃0081), on leaf spots of *Pharbitis purpurea* (L.) Voight, Dali, Yunnan Province, Coll. T.Y. Zhang, 2003 and dried ex-type cultures on PCA and PCA-filter paper in HSAUP₀₃0081.

Six species of *Alternaria* have been described so far on plants of *Convolvulaceae*. *A. pharbitidicola* is very different from *A. destruens* E.G. Simmons, *A. pharbitidis* T.Y. Zhang & W.Q. Chen and *A. calystegiae* Nelen, because conidia of the last three species are often catenulate and short beaked. *A. cuscutacidae* Rudakov, according to Simmons, appears in a few publications but never with a description or other validating information, and the isolates labeled *A. cuscutacidae* do not establish the relation with the original source, so it is an illegitimate species name. Among the previously described large-spored species, *A. pharbitidicola* somewhat resembles *A. bataticola* Ikata ex W.Yamam. and *A. dichondrae* Gambogi, Vannacci et Triolo in having long conidium beaks. However, the new taxon is different from *A. bataticola* in that conidia of the latter are cylindrically beaked and thicker- and darker-walled. The new species can be separated from *A. dichondrae* in that the conidium beak of the latter is always branched 2-4 times.



Fig.2 *Alternaria pharbitidicola*. Left: Conidia and conidiophores ex natural substrate, Upper right: Conidia ex culture on PCA, Middle and lower right: Sporulation pattern (PCA 7d.), (All above ex HSAUP₀₃ 0081, Bars=50 μ m)

Alternaria mouchaccae E.G. Simmons, Mycotaxon 13: 18-21, 1981.

Fig. 3

=*Ulocladium chlamydosporum* Mouch., Revue de Mycologie 36(2): 120, 1971.

Specimen examined: HSAUP₀₃ 0138 (=ZTYII₀ 0138), on leaf spots of *Agropyron* sp., Kashi, Xinjiang Uygur Autonomous Region; T.Y. Zhang, Aug. 2000.

This species is a new record for China.

Alternaria crotonicola T.Y. Zhang & J.C. David, Mycosystema, 8-9: 130, 1995-1996.

Specimen examined: HSAUP₀₃ 1032 (=ZM₀₃ 0532), on leaf spots of *Acalypha australis* L., Jinan, Shandong Province, Coll. Meng Zhang, 2003.

This is a new record for China.



Fig.3 Conidia and conidiophores of *Alternaria mouchaccae*. (ex HSAUP II₀0138. Bar=50 μ m)

Acknowledgments

We are grateful for presubmission comments and suggestions provided by Drs. Bryce Kendrick (8727 Lochside Drive, Sidney-by-the-sea, British Columbia, Canada V8L 1M8) and Mary E. Palm (APHIS, USDA, Beltsville, Maryland, USA). Our colleague, Mr. Yueming Wu, is also thanked for his kind help in inking drawings and technical support.

Literature Cited

Zhang TY (Ed.). 2003. Flora Fungorum Sinicorum, vol. 16, *Alternaria*. Beijing: Science Press, 1–281 (in Chinese).

中国链格孢属的分类研究 IX.

两个新种及两个中国新记录种

孙霞 张猛 张天宇*

(山东农业大学植物病理学系, 山东泰安 271018)

摘要: 报道生于凤仙花科植物上的一个新种, *Alternaria impatientis*, 生于旋花科植物上的一个新种, *A. pharbitidicola*, 和二个中国新记录种, *A. mouchaccae* 及 *A. crotonicola*。新分类单位的模式标本(田间标本和干制培养物)保存在山东农业大学植物病理学标本室(HSAUP)。

关键词: 苋菜, 冰草, 凤仙花, 牵牛

Changes and additions to the North American lichen flora. – IV.

KERRY KNUDSEN

kk999@msn.com

Herbarium, Botany & Plant Sciences Department
University of California, Riverside
Riverside, CA, 92521-0124, USA

JAMES C. LENDEMER

lendemer@acnatsci.org

Lichen Herbarium, Department of Botany
The Academy of Natural Sciences of Philadelphia
1900 Benjamin Franklin Pky., Philadelphia, PA, 19103, USA

Abstract. – *Acarospora intercedens* and *A. radicata* are placed in synonymy with *A. socialis*. *A. peltastica* and *A. utahensis* are placed in synonymy with *A. strigata*. *Thelocarpon albomarginatum* is placed in synonymy with *A. washingtonensis*. A neotype is selected for *A. peltastica*. A lectotype is selected for *A. strigata*. *Hypotrachyna afrorevoluta* is reported as new to North America.

1. *Acarospora socialis* H. Magn., Mycologia, 21: 252. 1929. TYPE: USA, California, Los Angeles Co., Santa Catalina Island, on mountain tops, *L.W. Nuttall* 478 (FH!, holotype).

Syn. nov. *Acarospora intercedens* H. Magn., Goteborgs Kungl. Vetensk. & Vitterhets. Samhalles Handl., sjätte foljden ser. B, 6(17): 15. 1956. TYPE: USA, California, Ventura Co., 3.5 miles up Matilija Canyon, Los Padres National Forest, W. of Matilija Hot Springs, elev. 450 m., *W.A. Weber*. *S-1040* (UPS!, holotype).

Syn. nov. *Acarospora radicata* H. Magn., Goteborgs Kungl. Vetensk. & Vitterhets. Samhalles Handl., sjätte foljden ser. B, 6(17): 14. 1956. TYPE: USA, Arizona, Pinal Co., Desert Mountains, SW of Superior, NW slope, just S of Picketpost Mountains, near Southwestern Arboretum, elev. 825 m., *W. A. Weber & J.B. McCleary* (UPS! holotype).

The major characteristics of *Acarospora socialis* H. Magn. are the formation of well-developed squamules, a stipe, and hyaline, simple spores that are usually broadly ellipsoid, 2.0–2.5 μm wide. For a current description of *A. socialis* refer to the first author's treatment in Vol. 3 of the Sonoran lichen flora (Knudsen in prep.)

Acarospora socialis is the most common yellow *Acarospora* in western North America, occurring in southern and central California and the Channel Islands, in the Mojave Desert, and from the Colorado Desert in California to New Mexico, and south into Mexico. The full range of its distribution in North America is not known, in great

part due to collections being referred to as *A. schleicheri sensu* Weber or *Pleopsidium*. Before Magnusson (1929a), Tuckerman (1882) and Hasse (1913) determined western North American specimens as *A. xanthophana*, a South American *Acarospora* that does not occur in North America. Also the current use of *A. socialis* in the Midwest by some lichenologists may be misapplied to specimens of *A. chrysops* (Tuck.) H. Magn., which appears to replace *A. socialis* from Texas and the Rocky Mountains east to Kansas and the Ozarks. Clauzade et al. (1981) indiscriminately lumped the yellow *Acarospora* of North America into *A. bella* (Nyl.) Jatta.

Individual specimens of *A. socialis* from different parts of its range can look quite different. This has led to a number of synonyms, only those which have been studied so far are made official here. Examination of numerous collections, combined with the field studies, turns up many intergrading forms and none of the morphotypes are stable. But one should be careful in assigning yellow *Acarospora* to *A. socialis* even within its current known range, as rarer *Acarospora* species often occur within the range of more common and successful species. One example is *A. epilutescens* with just a few reports from southern California, Arizona, and Texas (Knudsen 2005).

Herre (1910) applied his combination *Acarospora bella* (Nyl.) Herre to all yellow *Acarospora* in north and south America, including *A. socialis* occurring in the Santa Cruz Mountains of central California. Knudsen (2004) suggested that the name *A. bella* could be used by lichenologists in central California ad interim during the process of revision of the group, as being preferable to *Pleopsidium* or *A. schleicheri sensu* Weber and the name was included in Esslinger (1997). But with new data available it is best to shed the use of this name. The basionym of *A. bella*, is *Lecanora bella* Nyl., an illegitimate homonym of *Lecanora bella* Ach., and the correct name *A. xanthophana* (Nyl.) Jatta, in our opinion, should be used only for members of a group of high elevation South American yellow *Acarospora* that is in need of revision.

Magnusson's synonyms are based on a species concept that did not take into account the variability of this taxon. He segregated his species based on narrow differences in hymenium height, cortical thickness, apothecia color or width, and pruina. In this wide-ranging and successful taxon, there is considerable variation in these measurements and characteristics which make Magnusson's concepts impossible to apply. *Acarospora subalbida* auct. was applied to heavily pruinose specimens common in Topanga Canyon in the Santa Monica Mountains but specimens with varying amounts of pruina are common throughout the range of *A. socialis* (Knudsen 2005). *Acarospora intercedens* was applied to specimens from Matilija Canyon in Ventura County, California, which are reduced in size. Such reduced specimens, probably caused by stress through environmental factors, are common in *Acarospora* in western North America and in *A. socialis*. *Acarospora radicata*, which Magnusson (1956) himself recognized as close to *A. socialis*, are specimens with interascal plectenchyma in the apothecia caused by the retarded development of fertile apothecia in mature squamules, often in desert populations, where extended conidia production of infertile squamules appears to be a successful strategy for pioneering habitats.

Magnusson (1929a) originally selected the collection by L.W. Nuttall as the holotype of *A. socialis*. The later citation of a different collection as the type (Magnusson 1929b) is erroneous.

2. *Acarospora strigata* (Nyl.) Jatta, Malpighia, 20: 10. 1906.

Lecanora strigata Nyl., Annal. Sci Nat., 3: 155. 1855. TYPE: Chile, Coquimbo, ad saxa calcaea. Gay s.n. (H-Nyl #24898!, lectotype, **designated here**).

Syn. nov. *Acarospora peltastica* Zahlbr., Beih. Bot. Centralbl., 13: 161. 1902. TYPE: USA, California, Riverside Co., Palm Springs, ad saxa granitica, H.E. Hasse s.n. = *Lichenes Rariores Exsiccati* 75 (W!, neotype, **designated here**). (see discussion below).

Syn. nov. *Acarospora utahensis* H. Magn., Acta Horti Gotoburgensis, 19(1): 32. 1952. TYPE: USA, Utah, Wayne Co., sine loc., *S. Flowers* 364 (UPS!, holotype).

Acarospora strigata (Nyl.) Jatta occurs mainly throughout the deserts of western North America and in the mountains of South America on both acid and carbonate rock. The differences between substrates, slope aspect, humidity, wind, and access to water can cause extreme differences in specimens collected within sight of each other. Specimens may be epruinose, have different fissuring patterns with different ontogenies, several apothecia or a single dilated one, and even have the thallus blown away leaving only the blackened true exciple. The broadly attached areoles may be very reduced or in mesic situations with shade and high humidity up to 3 mm. across and 1 mm. high or more. The differences are not quite as bewildering as they appear and the one constant throughout the species is the occurrence of broadly ellipsoid spores (3.0-)4.0-6.5(-7.0) x (2.0-)2.5-3.0(-3.7) μm . If mature spores average less than 2.5 μm in width in a specimen, you usually have one of several other possible pruinose species.

Acarospora peltastica Zahlbr., was placed in division *Subglobosae* (Magnusson 1929b) and was delimited from other North American species as having spores globose or subglobose, and furrowed areoles from 2-4 mm. in diameter (Magnusson 1956). These characteristics are all within the normal range of variation in *A. strigata*. The immature spores of *A. strigata* are often clearly globose and become 4x2 μm , broadly ellipsoid, in the neotype of *A. peltastica*. In many Hasse specimens of *A. peltastica* from the Palm Springs area on the east slope of the San Jacinto Mountains spores can be found as large as 7 x 3 μm . It should also be kept in mind that broadly ellipsoid spores viewed in the ascus or loose at a wrong angle appear globose. The normal range of areoles in *A. strigata* is 0.3-4.0(-5.0) mm. in diameter. The sizes of areoles apparently depend on environmental conditions. The largest squamules on the east side of San Jacinto Mountains occur in shaded drainages on north slopes with spring-fed water and can easily get to 3-4 mm. in diameter. Furrows occur in the upper syncortex and cut down to the upper pigmented layer of the eucortex. In many specimens this furrowing is well-developed in a cross-hatched pattern that is 70-100 μm deep, especially in large areoles. In these cases furrowing appears to be caused by differential expansion of medulla and eucortex to the syncortex. Zahlbruckner (1902) cited the type of *A. peltastica* as H.E. Hasse 662 however, that collection could not be located. Thus, an exsiccate collection from the same locality, without number or date, and also collected by Hasse is here selected as the neotype.

Acarospora utahensis was segregated from *A. strigata* on basis of larger spores 9-13 x 5-6 μm (Magnusson 1956). Herre himself, who sent the specimens to Magnusson, annotated the holotype packet with the spore size "4-6.5 x 2-4 μm ." The examination

of the spores of the holotype agree with Herre's observation except no width was seen above $3.4\ \mu\text{m}$ and the specimen falls easily within the normal range of variation in *A. strigata*. We have no explanation for Magnusson's observation.

Specimens of *A. strigata* should be carefully determined since several taxa are superficially similar and easily misidentified as this taxon. Pruinoso specimens with a C+ red cortex and broadly ellipsoid spores are the rare and usually epruinoso *A. nevadensis* H. Magn. Pruinoso specimens with spores that are narrowly ellipsoid are usually *A. veronensis* (C-, lacking gyrophoric acid) or *A. obpallens* (C+ red, gyrophoric acid).

The collections of *A. strigata* we have seen have been haphazard. More careful and intense collections in various regions may reveal other species. Morphological variation may also be due partly to different lineages within the taxon that have not speciated due to the success of *A. strigata* in adapting to varying harsh habitats. In some locations these lineages may re-converge.

3. *Acarospora washingtonensis* H. Magn., Ann. Crypt. Exot., 6: 46 (1933).

TYPE: USA, Washington, Roslyn, 1931, I.E. Howard s.n., (UPS!, holotype)

Syn. nov. *Thelocarpon albomarginatum* Herre, J. Wash. Acad. Sci., 2: 384. 1912. TYPE: USA, California, Santa Cruz Mountains, Devil's Cañon, on a loose rock lying on earth, elev. 2400 ft., 1906, A.W.C.T. Herre s.n. (F!, holotype)

Acarospora albomarginata (Herre) G. Salis., Lichenologist: 3: 191. 1966. comb. illeg. non *Acarospora albomarginata* B. de Lesd. (1911).

Acarospora washingtonensis H. Magn., is a rare lichen known from Arizona (Magnusson 1937), California (Herre 1912), and Washington (Magnusson 1933). Herre first collected this species in 1906 in the Santa Cruz Mountains of central California.

The same lichen was collected by I.E. Howard in Washington in 1931 and he sent a specimen to Magnusson who described it as *A. washingtonensis* (Magnusson 1933). In 1937 Magnusson reported it as being collected by K. Bartlett in Arizona near Oraibi. The taxon is in need of further study especially its relation to *A. elevata* H. Magn.

4. *Hypotrachyna afrorevoluta* (Krog & Swinscow) Krog & Swinscow, Lichenologist, 19: 420. 1987.

Parmelia afrorevoluta Krog & Swinscow, Norweg. J. Bot., 26: 22. 1979. TYPE: Kenya, Central Province, Nyeri District, Aberdare Mts., 10 km W Tusha, on trees in ericaceous zone, H. Krog 3k 31/188 (O!, holotype).

Parmelinopsis afrorevoluta (Krog & Swinscow) Elix & Hale, Mycotaxon, 29: 242. 1987.

While attempting to resolve the material referred with question to *Parmelinopsis spumosa* (Asah.) Elix & Hale by Harris & Lendemer (2005) and Lendemer & Harris (2004) the second author examined a large number of pustulose *Hypotrachyna*/*Parmelinopsis* specimens from eastern North America. It became clear that several taxa were involved, one of which was *H. afrorevoluta*.

Originally described from Africa by Krog & Swinscow (1979) the species was separated from *H. revoluta* (Flot.) Hale by the presence of submarginal sorediate

pustules and marginal cilia. Subsequent to its description the species has been widely reported from other regions including China (Chen et al. 2003), Norway (Santesson 1993), and South America (Adler & Elix 1992). The presence of the species in North America is not unexpected considering the records from Norway as well as its generally widespread distribution. The correct generic placement of *H. afrorevoluta* is somewhat problematic (see synonymy above and various regional checklists not cited here), we follow Krog & Swinscow (1987) and retain the species in *Hypotrachyna* pending further study.

In eastern North America *H. afrorevoluta* has previously been confused with *Parmelinopsis spumosa* from which it differs chemically in containing the hiascic acid complex in addition to gyrophoric acid and lacking a UV+ blue-white unknown, geographically in being absent from the southeastern coastal plain, and morphologically in having revolute lobe margins and a larger thallus. *Hypotrachyna afrorevoluta* differs from the superficially similar *H. showmanii* in having emaculate lobe tips, sorediate pustules, a more loosely adnate thallus, and revolute lobe margins. It is also more densely rhizinate with long, occasionally branching rhizines.

The status of *Hypotrachyna showmanii* in eastern North America will be re-evaluated by Lendemer & Harris (in prep.). In *H. showmanii* the pustules do not become sorediate but are easily broken following collection and subsequently mistaken for schizidia or soredia. *Hypotrachyna showmanii* also has conspicuously maculate lobe tips, unlike *H. afrorevoluta*.

Hypotrachyna afrorevoluta is widespread in north/central North America and we have seen material from coastal Maine, USA and throughout the southern Appalachians. The species is likely uncommon, and the identification of some specimens can be problematic, especially if they are old or fragmentary.

Selected Specimens Examined. - USA. Maine. Hancock Co.: Acadia National Park, Mount Desert Island, to the east of Gilley Field Trail descending Bernard Mt., in conifer dominated forest, on *Acer rubrum*, 125 m., UTM 19 4906061.7N 550554.3E, N. Cleavitt 1611 & D. Werier (hb. Cleavitt!, hb. Lendemer!). North Carolina. Macon Co.: Nantahala National Forest, N slope of Wayah Bald along Appalachian Trail, moist mixed hardwoods, on *Quercus*, ca. 1535 m., 35° 11'N 83° 34'W, R.C. Harris 42822 (NY!). Transylvania Co.: Gorges State Park, Bearwallow Fields, mixed forest along banks of Toxaway River, on *Alnus*, 1475 ft, 35° 04'N 82° 54'W, J.C. Lendemer 4602 & E. Tripp (hb. Lendemer!); Gorges State Park, east facing slope below Grassy Ridge, ca. ½ mi. N of Ray Fisher Farm, acid cover forest, on *Acer*, ca. 2500 ft., 35° 05'N 82° 56'W, J.C. Lendemer 4713 & E. Tripp (NY!, hb. Lendemer!). West Virginia. Pendleton Co.: Monongahela National Forest, Spruce Knob National Recreation Area, trunk of tree on dry, steep slope, along Forest Service Road #112, ca. 4400 ft., W.R. Buck B-996 (NY!).

Acknowledgements

Thanks to Othmar Breuss, Nat Cleavitt, Richard C. Harris, Jim Hinds, Robert Lücking, Theodore L. Esslinger, Thomas Nash III, Einar Timdal, and Shirley Tucker. Also to the curators of the following herbaria for the loan of materials cited herein F, FH, H, NY, O, OSU, UPS. We also thank Robert Lücking and Richard C. Harris for providing peer reviews of the manuscript.

Literature Cited

- Adler MT, Eix JA. 1992. New records of *Hypotrachyna* and *Parmelinopsis* lichens (Ascomycotina, *Parmeliaceae*) from northwest and central Argentina. *Mycotaxon*, 43: 283-288.
- Clauzade G, Roux C, Rieux R. 1981. Les *Acarospora* de l'Europe occidentale et de la region mediterraneenne. *Bulletin du Musee d'Histoire Naturelle de Marseille*, 41: 41- 93.
- Chen J-B, Wang SL, Elix JA. 2003. *Parmeliaceae* (Ascomycota) lichens in China's mainland I. The genera *Canomaculina*, *Parmelina*, *Parmelinella* and *Parmelinopsis*. *Mycotaxon*, 86: 19-29.
- Esslinger TL. 1997. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: <http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm> (First Posted 1 December 1997, Most Recent Update 14 June 2005), Fargo, North Dakota.
- Harris RC, Lendemer JC. 2005. Contributions to the Lichen Flora of Pennsylvania: A Checklist of the Lichens Collected During the 1st Howard Crum Bryological Workshop, Delaware Water Gap National Recreation Area. *Opuscula Philolichenum*, 2: 1-10.
- Hasse HE. 1913. The lichen flora of Southern California. *Contributions to the United States National Museum*, 17(1): 1-132.
- Herre AWCT. 1910. The lichen flora of the Santa Cruz Peninsula, California. *Proceedings of the Washington Academy of Sciences*, 12: 27-269.
- Herre AWCT. 1912. Supplement to the lichen flora of the Santa Cruz Peninsula, California. *Journal of the Washington Academy of Sciences*, 2: 380-386.
- Jatta A. 1906. Lichenes lecti in Chili a cl. G. J. Scott-Elliot. *Malpighia*, 20: 1-13.
- Knudsen K. 2004. A study of *Acarosporas* in the lichen flora of the Santa Cruz Peninsula by A. W. C. T. Herre. *Bulletin of the California Lichen Society*, 11(1): 10-15.
- Knudsen K. 2005. *Acarospora epilutescens* rediscovered. *Opuscula Philolichenum*, 2: 11-13.
- Knudsen K. in prep. *Acarospora*. In *Lichen Flora of the Greater Sonora Desert Region*, v. 3.
- Krog H., Swinscow TDV. 1979. *Parmelia* subgenus *Hypotrachyna* in East Africa. *Norwegian Journal of Botany*, 26: 11-43.
- Krog H., Swinscow TDV. 1987. New species and new combinations in some parmelioid lichen genera, with special emphasis on East African taxa. *Lichenologist*, 19: 419-431.
- Lendemer JC, Harris RC. 2004. A checklist of the lichens collected on the 28th A. Leroy Andrews Foray. *Evansia*, 21(2): 88-100.
- Lendemer JC, Harris RC. In prep. That status of *Hypotrachyna showmanii* is eastern North America.
- Magnusson AH. 1929a. The yellow species of *Acarospora* in North America. *Mycologia*, 21: 249-260.
- Magnusson AH. 1929b[1930]. A monograph of the genus *Acarospora*. *Kongl. Svenska Vetenskaps-Akademiens Handlingar*, 7: 1-400.
- Magnusson AH. 1933. Supplement to the Monograph of the genus *Acarospora*. *Ann. Crypt. Exot.*, 6: 13-48
- Magnusson AH. 1937. Additional notes on *Acarosporaceae*. *Meddelelser fran Göteborgs Bot. Trädgård*, 12: 87-103.
- Magnusson AH. 1952. New crustaceous lichen species from North America. *Acta Horti Gotoburgensis*, 19(1): 31-49
- Magnusson AH. 1956. A second supplement to the monograph of *Acarospora* with keys. *Goteborgs Kungl. Vetensk. & Vitterhets. Samhalles Handl., sjatte foljden, ser. B* 6(17): 1-34.

- Nylander W. 1855. Additamentum ad floram cryptogamicam Chilensem, quo lichenes praecipue saxicolos exponit. Annales des Sciences Naturelles, 3: 145-187.
- Pitard J, Bouly de Lesdain M. 1911. Contribution à l'étude des lichens de Tunisie. Bulletin de la Société Botanique de France, 243-254.
- Salisbury G. 1966. A monograph of the lichen genus *Thelocarpon* Nyl. Lichenologist, 3: 175-196.
- Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway, SBT-förlaget, Lund.
- Tuckerman E. 1882. A synopsis of the North American lichens. Part. I, comprising the Parmeliacei, Cladonieae and Coenogonieae. S.F. Cassino\Boston. XX, 262 pp.
- Zahlbruckner A. 1902. Diagnosen neuer and ungenugend beschriebener kalifornischer Flechten. Beihefte Bot. Centrabl., 13: 149-163.

A new species and its phylogenetic placement in the *Didymella/Phoma* complex (*Phaeosphaeriaceae*, *Pleosporales*)

MONICA S. TORRES¹, JAMES F. WHITE, JR.¹, GUADALUPE CAZARES¹, MARSHALL BERGEN¹, JOSEPH F. BISCHOFF², AND RAYMOND F. SULLIVAN³

Jwhite@aesop.rutgers.edu

¹*Department of Plant Biology and Pathology, Rutgers University
New Brunswick, New Jersey 08901*

²*National Center for Biotechnology Information, National Institutes of Health,
Bethesda, Maryland 20894*

³*Center for Science & Technology, Kean University,
Union, New Jersey 07083*

Abstract - A proposed new species, *Phoma billsii* sp. nov., was obtained from soil samples from Hawaii. The features of this new species are described and it is distinguished from other species to which it is similar. Large subunit 28S rDNA sequences are employed to place this new species phylogenetically. *Phoma billsii* is placed in a *Didymella/Phoma* complex in family *Phaeosphaeriaceae* of the *Pleosporales*. Sequence similarity of ITS1 rDNA was used to evaluate distinctness from similar species in *Didymella* and *Phoma*. A phylogenetic approach for classification of phomoid fungi is advocated.

Key words - *Phoma billsii*, *Pleosporales*, taxonomy

Introduction

The form genus *Phoma* Sacc. was proposed in 1880 by Saccardo (1880). Since establishment of the genus, thousands of species have been described and separated by host substrate and by morphological differences (Sutton 1980; Boerema et al. 2004). Most fungi referred to *Phoma* pertain to the *Pleosporales* (Wehmeyer 1961; Sutton 1980; Grondona et al. 1997; Boerema et al. 2004). Historically, *Phoma* has been a repository for any pycnidial coelomycete with colorless and one to two-celled conidia (Grove 1935; Sutton 1980). Recently Boerema and colleagues have published a comprehensive identification manual for cultural identification of *Phoma* (Boerema et al., 2004). This work was the culmination of decades of taxonomic study of *Phoma* and *Phoma*-like species by an international suite of mycologists (e.g., Grove 1935; Morgan-Jones 1988a,b; Punithalingam 1990; Rai 1998; de Gruyter 2002; Boerema

et al. 2004). The monograph facilitates identification of numerous *Phoma* isolates; however, classification of many species in *Phoma* still carries with it uncertainty as to precise phylogenetic affinity. One of the challenges for mycologists is the development of a phylogenetic base for classification of fungal species in groups like *Phoma* where classification lacks phylogenetic clarity and teleomorphs are rarely observed (Alexopoulos, Mims, Blackwell 1996).

In this study, we document morphological and cultural features of a new species of *Phoma* and place it in a phylogenetic context.

Materials and Methods

Fungal Material: Isolates of *Phoma billsii*, *Phoma cucurbitacearum* (Fr.:Fr.) Sacc. (GSB10), and *Phoma pomorum* Thüm. (GSB12) were obtained from soil collected by Gerald Bills in 1988 from a sugarcane field near Olowalu, Maui, Hawaii. Isolations from soil samples were made using the ethanol pasteurization technique (Bills et al., 2004). Once isolated, cultures were grown on potato dextrose agar (PDA). Specimens obtained from the American Type Culture Collection (ATCC) (Table 1) were revived in potato dextrose broth and subsequently plated on PDA. Cultures were maintained at approximately 23 °C in an irregular light (fluorescent room lighting)/dark cycle. Specimens of all collections were submitted to the Rutgers University Plant Pathology Herbarium (RUTPP) and representative cultures were sent to the ATCC in Manassas, Virginia.

Microscopy: Specimens of all isolates were examined by simple squash mounting and *P. billsii* was further examined by embedding and sectioning pycnidia (Figs. 1-4; 6-9). For sectioning, blocks of agar with pycnidia were fixed in FAA (five parts stock formalin: five parts glacial acetic acid: 90 parts 50% ethyl alcohol) for approximately 5 days. Tissue was then dehydrated and embedded in L. R. White® acrylic embedding medium (Polysciences, Inc., Warrington, PA) and 1 µm sections were obtained using glass knives (Figs. 6-9). Sections were stained on a slide warmer for 30 s in toluidine blue stain (0.1% aqueous) and examined with a phase contrast microscope. Conidial, pycnidial, and mycelial examinations were made in squash mounts in aniline blue stain (0.1% aqueous) (Figs. 1-4). Size measurements are an average of at least 20 individual measurements.

Cultural studies: Isolates were cultured on oatmeal agar (OA; Fig. 5), malt-extract agar (MEA), and PDA, prepared as outlined by Boerema et al. (2004). In addition we employed Czapek cellulose agar (CCA) to stimulate pycnidial production. CCA medium contained the following: fibrous cellulose powder (Whatman) 10 g, sodium nitrate 2 g, dipotassium phosphate 1 g, magnesium sulfate 0.5 g, potassium chloride 0.5 g, ferrous sulfate 0.01 g, bacto-agar 15 g, distilled water 1 litre. All media were inoculated using 7 mm plugs cut from margins of colonies growing on CCA plates. Plates were maintained at 23 °C in an alternating light/dark cycle and examined after 5 and 7 days of growth. Descriptions represent observations after 5 days. For the sodium hydroxide spot test one drop of 10% sodium hydroxide solution was placed on mycelium at the margins of 7-day-old colonies growing on OA and MEA media after Boerema et al. (2004).

Identifications of Isolates: Isolates from soil and leaf litter were identified using

a combination of sequence homology, morphology, and cultural characteristics. For *Phoma cucurbitacearum* (GSB10) an exact sequence match in LSU sequences was obtained with *Didymella bryoniae* (Auersw.) Rehm (isolated from cantaloupe in Arizona in 1997; IMI 373225) and cultural and morphological characteristics corresponded to the *Phoma cucurbitacearum* state of that species (Boerema et al 2004). *Phoma pomorum* (GSB12) was identified through examination of cultural and morphological features (White, Morgan-Jones 1986; Boerema et al. 2004).

Sequencing and Analyses: Amplification and sequencing of 18S small subunit (SSU) rDNA, 28S large subunit (LSU) rDNA, and internal transcribed spacer sequence 1 (ITS1) was done as previously described (White et al. 1990; Sullivan et al. 2001) and voucher accession numbers are provided in Table 1.

Table 1. Taxa used in ITS and LSU analyses

Taxa	GenBank #	Culture/Voucher #
<i>Aureobasidium pullulans</i>	AF050239	ATCC 62921
<i>Clathrospora diplospora</i>	U43481	IMI 68086
<i>Cochliobolus heterostrophus</i>	AF163992	---
<i>Delphinella strobiligena</i>	AY016358	CBS 735.71
<i>Didymella bryoniae</i>	AY293792/AF046014	IMI 373225
<i>Didymella lycopersici</i>	AF046015	AUAM1431
<i>Dothidea ribesia</i>	AY016360	CBS 195.58
<i>Dothidea sambuci</i>	AF382387	CBS 198.58
<i>Lewia infectoria</i>	U43482	IMI 303186
<i>Leptosphaeria doliolum</i> 1	U43475	ATCC 32815
<i>Leptosphaeria doliolum</i> 2	U43474	ATCC 32814
<i>Melanomma radicans</i>	U43479	ATCC 48522
<i>Mycosphaerella mycopappi</i>	U43480	ATCC 64711
<i>Phoma americana</i>	AF046017	AUAM3376 ²
<i>Phoma billsii</i>	AY293789	ATCC MYA3680
<i>Phoma cucurbitacearum</i> (GSB10)	AY293786	ATCC MYA3681
<i>Phoma glomerata</i> (South River)	AF126819	ATCC MYA2373
<i>Phoma herbarum</i>	AY293791	ATCC 12569
<i>Phoma macrostoma</i>	AF046020	PD68/1014 ²
<i>Phoma multirostrata</i>	AF046019	AUAM2409 ²
<i>Phoma pomorum</i> (GSB12)	AY293787	ATCC MYA3682
<i>Phoma</i> sp. (<i>Westerdykella</i>)	AY293790	ATCC 22167
<i>Phoma</i> sp.	AY293788	ATCC 26648
<i>Phoma</i> sp. (Turkey Swamp)	AY293785	ATCC MYA3683
<i>Pleomassaria siparia</i>	AY004341	---
<i>Pleospora betae</i>	U43483	IMI 156653
<i>Pleospora herbarum</i> 1	U43476	ATCC 11681
<i>Pleospora herbarum</i> 2	AF382386	CBS 191.86
<i>Pyrenophora trichostoma</i>	U43477	ATCC 44111
<i>Trematosphaeria heterospora</i>	AY016369	CBS 644.86
<i>Westerdykella cylindrica</i>	AY004343	CBS 454.72

¹--- indicates that voucher accession not available.

²Sequences were obtained directly from dried herbarium specimens from the Auburn University Mycological Herbarium (AUAM) in Auburn, Alabama or Plantenziektenkundige Dienst (PD) in Wageningen, The Netherlands.

In a few instances sequences were obtained directly from dried herbarium specimens (Reddy et al. 1998). The GCG programs Gap, Pileup and the SeqLab interface for the Wisconsin Package Version 9.1 (Genetics Computer Group, Madison, WI) were used to analyse sequences, generate alignments and make manual adjustments. PAUP version 4b10 (Swofford 1999) was used for sequence similarity analysis of ITS1 data and for phylogenetic analysis of LSU and SSU sequences. PAUP's Base Frequency program was used to get the expected base frequency for each taxon and to do a Chi-square test for homogeneity of base frequencies across taxa. Preliminary analyses were conducted on all sequence regions using parsimony and distance options. Because of the lack of sufficient variability in SSU rDNA sequences and its failure to distinguish families *Phaeosphaeriaceae* and *Leptosphaeriaceae* (Rossman et al. 2002), the SSU region was not employed in further analyses to place *P. billsii* phylogenetically. MODELTEST (Posada, Crandall 1998) was used to establish the model of DNA evolution that best fit the data model for the LSU data (Treebase submission ID number SN2485; Akaike Information Criterion) and maximum likelihood analysis with 1000 replicates was performed (using PAUP) with the resulting model. The model used was TrNef+I+G; $-lnL = 3679.6941$, $AIC = 7373.3882$; base frequencies $A = 0.2492$, $C = 0.2148$, $G = 0.2928$; substitution model with rate matrix R (a) $[A-C] = 1.0000$, R (b) $[A-G] = 2.2880$, R (c) $[A-T] = 1.0000$, R (d) $[C-G] = 1.0000$, R (e) $[C-T] = 7.0409$, R (f) $[G-T] = 1.0000$; Among-site rate variation (I) = 0.4267, Variable sites (G) with gamma distribution = 0.8191.

MrBayes 3.0, a Bayesian phylogenetic inference program (Huelsenbeck, Ronquist 2001), was used to determine branch support (posterior probabilities). Bayesian analysis was run with four Markov chains Monte Carlo (three cold, one heated) for 1,000,000 generations, sampling every 100 generations (including the first generation). The trees that were not asymptotic (the first 50 trees) were discarded ("burn-in"; Huelsenbeck 2000). Bayesian analysis was done three times with a total of 29850 trees resulting. These trees were imported into PAUP and a 50% majority-rule consensus tree was produced to determine posterior probabilities. Support values are reported on the maximum likelihood tree (Fig. 10).

Taxonomy

Phoma billsii was found to be distinct from previously described species. Its features are outlined in the taxonomic description below.

Phoma billsii J. F. White **sp. nov.**

Figs. 1-9.

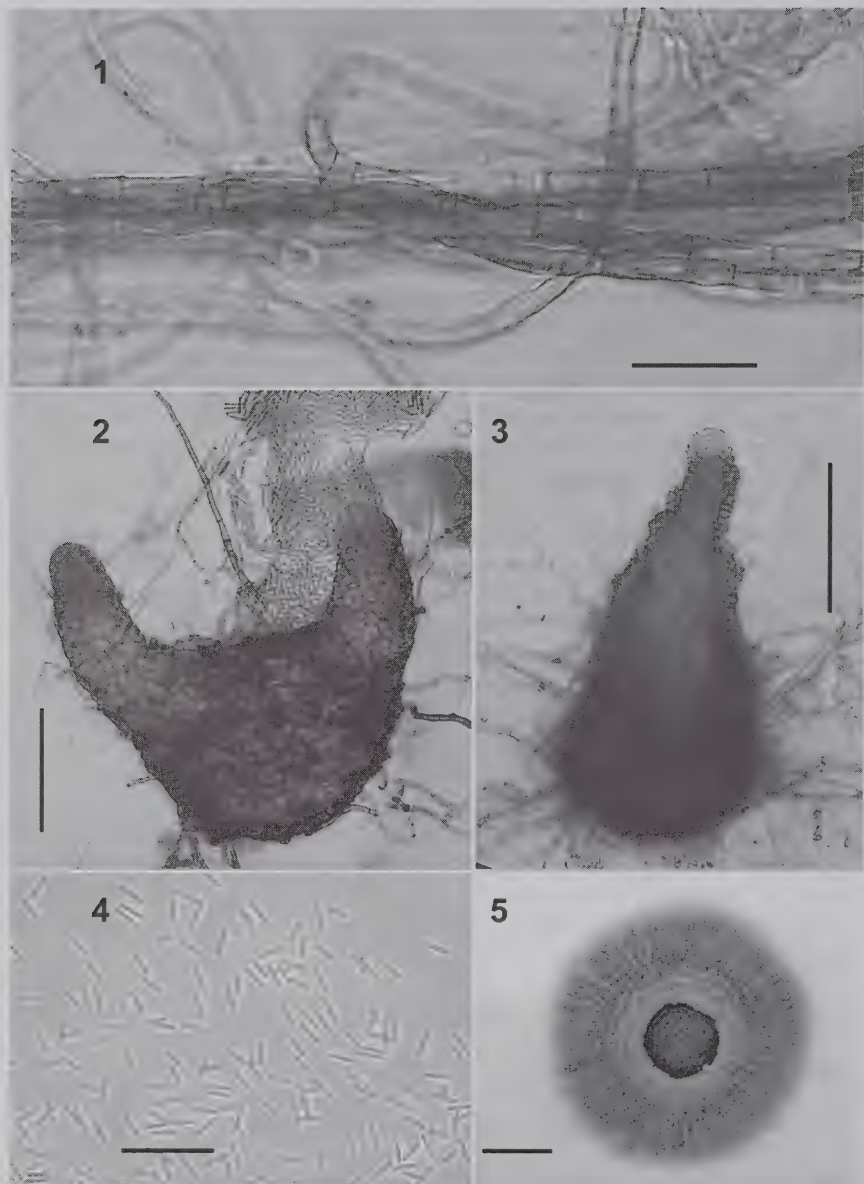
[Etym. *Phoma billsii* is named for the mycologist Dr. Gerald F. Bills]

Coloniae in agaro decocto tuberorum olivaceae, lanosae, margine sparsae, post 5 dies 23 °C ad 39 mm diametro, reverso negro. Mycelium ex hyphis septatis, ramosis, subhyalinis vel pallide brunneis, 1-8 µm crassis compositum. Pycnidia solitaria, ampulliformae, 1-2 rostrata, brunnea, partim immersa, pseudoparenchymatica, 1-2 ostiolata, 60-100 X 80-200 µm; paries cellularum isodiametricarum compositum. Cellulae conidiogenae hyalinae, simplices, ex cellulis interioribus parietis pycnidii, ampuliformes, 3-5 µm. Conidia enteroblastica, hyalina, simplicia, cylindrica, 3-4 X 11-14 µm. Holotypus hic designatus: Phoma billsii (RUTPP); ex-typus ATCC MYA3680.

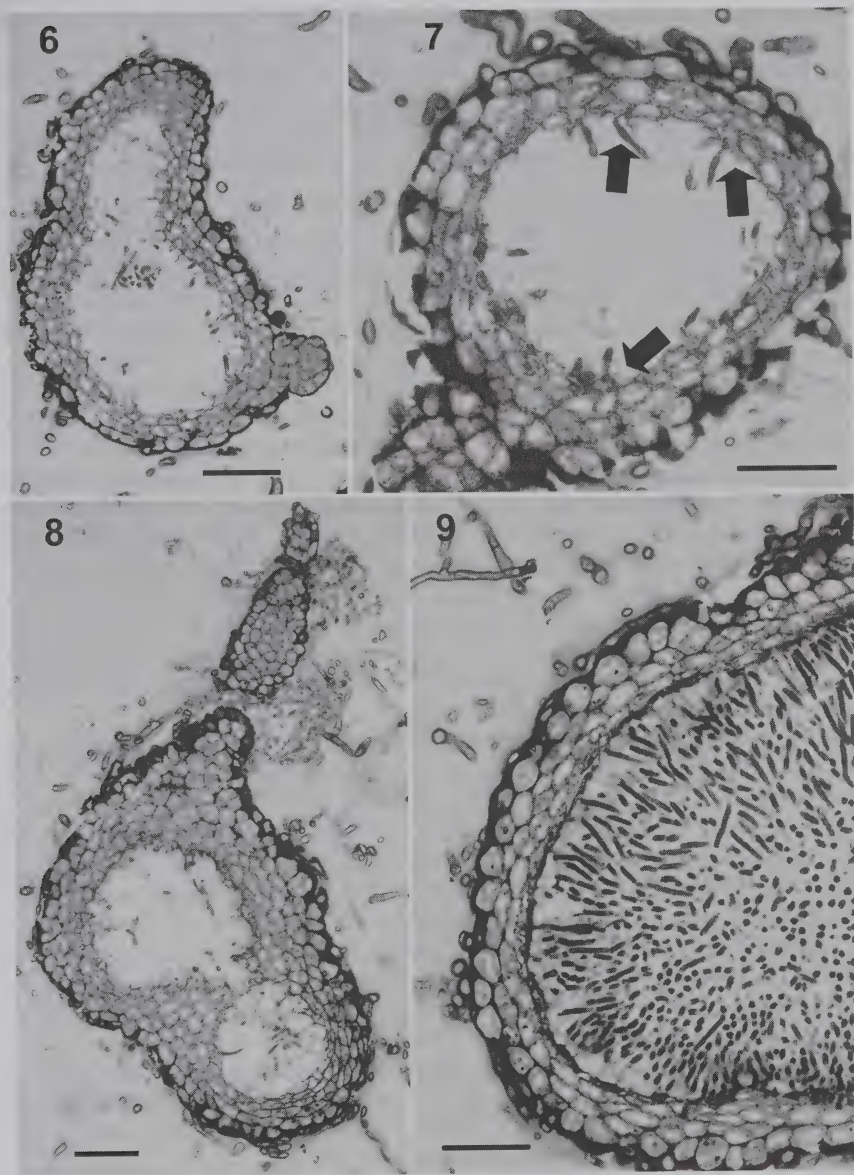
Technical Description: Colonies on MEA dark olivaceous, with sparse aerial mycelium, particularly in a wide marginal zone, attaining a diameter after 5 days of 37 mm at 23 °C, reverse olivaceous; on PDA dark olivaceous, lanose aerial mycelium, black and stromatic beneath surface, margin thin and cream colored, attaining a diameter after 5 days of 39 mm, reverse black; on CCA colonies not pigmented, with sparse mycelium and almost no aerial mycelium, attaining a diameter after 5 days of 13 mm (after 30 days diameter 70 mm with abundant pycnidia), reverse not pigmented; on OA light olivaceous to brown, with sparse aerial mycelium, attaining 39 mm after 5 days (52 mm after 7 days), zonate, with inner zone 3-4 mm across and brown, middle zone 4-5 mm across and darker brown with abundant pycnidia, outer zone 4-5 mm across and light olivaceous with sparse pycnidia (Fig. 5), reverse zonate and similar to above but obscured by medium. On all media pycnidia produced abundantly through a meristogenous process, partly immersed in the agar, except in CCA where pycnidia were both deeply immersed and partially immersed in medium and formed along strands of roping melanized mycelium (Fig. 1) that tended to radiate from centers of colonies. Mycelium composed of septate, branched, subhyaline to pale brown, smooth 1-8 µm wide hyphae, sometimes aggregated into closely appressed strands (Fig. 1). Pycnidia solitary, flask-shaped, light brown to blackish brown, often partly immersed, pseudoparenchymatous, with 1 or 2 ostioles that when immature appeared to contain isodiametric multicellular occlusions (Figs. 2, 3), bearing necks ranging 80-100 µm long and 30-40 µm wide at the extreme tip, 60-100 X 180-200 µm; pycnidial wall composed of isodiametric to ellipsoidal cells 3-6 µm, 3-6 layers, 7-10 µm thick (Figs. 2, 6-9). Conidiogenous cells phialidic, hyaline, simple, smooth-walled, borne on the innermost cells of the pycnidial wall, subglobose to broadly flask-shaped, isodiametric in size, 3-5 µm (Fig. 7). Conidia enteroblastic, hyaline, simple, eguttulate to guttulate with 4-6 large guttules in a line through the length of conidia, cylindrical, obtuse at each end, smooth, aseptate, 3-4 µm wide by 11-14 µm long (Figs. 4, 9). No chlamydospores were observed on any medium although simple hyphal swellings were present. Teleomorph unknown. The sodium hydroxide spot test (Boerema et al. 2004) gave an immediate orange-rust pigment that faded after 15 min on OA cultures; but no color reaction on MEA. Holotype: *Phoma billsii*, isolated from a soil sample from Olowalu, Maui, Hawaii (RUTPP); ex-type ATCC MYA3680.

Discussion

Comparisons to similar species: This species is distinguished from other species classified in *Phoma* due to its cultural, morphological, and rDNA sequence differences. *Phoma billsii* bears similarity to *Phoma zae-maydis* Punith. in conidial size and sodium hydroxide reaction (Punithalingam 1990; Boerema et al. 2004). However, *P. billsii* may be distinguished from it by: 1) pycnidia of *P. zae-maydis* are not bi-rostrate; and 2) colonies of *P. zae-maydis* on OA are colorless to grey with black sectors rather than concentrically zonate with brown and olivaceous green zones as observed in *P. billsii*. In addition, the teleomorph of *P. zae-maydis* is *Mycosphaerella zae-maydis* Mukunya & Boothr. Sequence analyses using LSU (Fig. 10) and ITS1 (Table 2) rDNA placed *P. billsii* in the *Didymella* group of *Phoma* species (100% branch support) rather



Phoma billsii. Figs. 1-5. Morphological and cultural features. 1. Hyphae from CCA showing roping mycelium (bar = 23 μ m). 2. Bi-rostrate pycnidium from CCA medium (bar = 80 μ m). 3. Pycnidium with a single ostiole showing the multicellular ostiolar plug (arrow; bar = 90 μ m). 4. Conidia from CCA (bar = 60 μ m). 5. Five-day-old colony on OA showing zonate character (bar = 8 mm).



Phoma billsii. Figs. 6-9. Pycnidial sections. 6. Section showing a uni-locular pycnidium (bar = 10 μ m). 7. Section of pycnidium showing conidiogenous cells (arrows; bar = 10 μ m). 8. Section showing bi-locular pycnidium (bar = 10 μ m). 9. Section of pycnidium showing ventor filled with conidia (bar = 10 μ m).

than in the *Mycosphaerella* clade. Using ITS1 rDNA, *Phoma americana* Morgan-Jones & J. F. White was found to be most similar with a 98.5% sequence similarity (Table 2). *Phoma billsii* differs from this species in that *P. americana* possesses multicellular chlamydospores and conidia that are somewhat shorter 5–8 μm , although it is similar in other cultural features. None of the previously treated species of *Phoma* possess the suite of features exhibited by *P. billsii* (Boerema et al. 2004).

Phoma Section Placement: Boerema (1997) and de Gruyter (2002) divided *Phoma* into nine sections: *Phoma* section *Phoma* Sacc. including species with ellipsoidal to cylindrical conidia and pycnidia that are pseudoparenchymatous; section *Heterospora* Boerema et al. that includes species characterized by possession of both large and small conidial sizes; section *Paraphoma* (Morgan-Jones & J. F. White) Boerema including species with pycnidia that bear seta-like appendages; section *Peyronellaea* (Goid. ex Togliani) Boerema including species with multicellular chlamydospores; section *Phyllostictoides* Žeberle ex Boerema including species where a minority of conidia develop septa; section *Sclerophomella* (Höhn.) Boerema et al. including species where pycnidia become thick-walled and sclerenchymatous; section *Plenodomus* (Preuss) Boerema et al. including species with thick-walled pycnidia; section *Macrospora* Boerema et al. including species with conidia that are notably elongated; and section *Pilosa* Boerema et al. including species with pilose pycnidia (Boerema 1997; Boerema et al. 2004). The species of the first six sections have teleomorphs, where known, in *Didymella* Sacc. (*Phaeosphaeriaceae*). Section *Plenodomus* has teleomorphs, where known, in the *Leptosphaeriaceae*. Section *Macrospora* teleomorphs, where known, are in *Mycosphaerella* Johanson (*Mycosphaerellaceae*). Section *Pilosa* has teleomorphs in *Pleospora* Rabenh. ex Ces. & de Not. (*Pleosporaceae*).

Based strictly on morphology *P. billsii* is placed in *Phoma* section *Macrospora* due to its elongate conidia. The type of section *Macrospora* is *P. zaeae-maydis* with teleomorph *Mycosphaerella zaeae-maydis*. However, the LSU analysis places *P. billsii* in a clade that contains *Didymella bryoniae* (100% branch support) (Fig. 10). *Phoma billsii* did not group with the *Mycosphaerellaceae* in any analysis. Further, the *P. billsii* ITS1 sequence was 96–98.5% similar to *Didymella lycopersici* Kleb., *P. americana*, *P. glomerata* (Corda) Wollenw. & Hochapfel, *P. macrostoma* Mont., and *P. multirostrata* (P.N.Mathur et al.) Dorenb. & Boerema (Table 2). This similarity is in line with species in the same genus. *Didymella bryoniae* and *D. lycopersici* were themselves only 96.3% similar to one another. These results suggest that *P. billsii* is likely derived from a *Didymella* sp. (*Phaeosphaeriaceae*), although without an observed teleomorph we cannot be certain. We propose that *P. billsii* should be classified as a large conidial species in section *Phoma* since its features and phylogenetic affinities most closely match this section (Fig. 10; Table 2). *Phoma herbarum* Westend. is the type of genus *Phoma* and section *Phoma* (Boerema et al. (2004).

Development of a Phylogenetic Context for Phoma: The genus *Phoma* is generally considered by most modern mycologists to be taxonomically problematical due to difficulties in distinguishing species from one another and uncertain phylogenetic affinities (Boerema 1970; Sutton 1980; Morgan-Jones 1988a; Reddy et al. 1998; Boerema et al. 2004; Hawksworth 2004). *Phoma*, as morphologically defined, is not a

monophyletic genus, but instead consists of species that are distributed throughout the *Pleosporales* (Boerema et al. 2004; Fig. 10). It is possible that the *Phoma* anamorphic state was a feature of fungi in the lineage that gave rise to the *Pleosporales*. This would explain why *Phoma* anamorphs occur sporadically in several families of the *Pleosporales* (Boerema et al. 2004). Reliance on the *Phoma* anamorph to define the genus *Phoma* has resulted in a situation where classification in the genus carries little evolutionary information.

Table 2. Similarity matrix derived from the sequence data of the ITS1 region in seven species of *Didymella* and *Phoma*.

Taxa	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) <i>P. billsii</i>	---						
(2) <i>P. americana</i>	98.5	---					
(3) <i>P. macrostoma</i>	98	99.2	---				
(4) <i>P. glomerata</i>	98	98.8	99.2	---			
(5) <i>P. multirostrata</i>	97.1	98	97.1	96.7	---		
(6) <i>D. lycopersici</i>	96.1	96.7	96.7	95.9	96	---	
(7) <i>D. bryoniae</i>	93.5	94.6	95.4	94.6	94.6	96.3	---

Culture collections and sequence databases worldwide contain numerous representatives of fungi identified to genus *Phoma* (Bridge et al. 2003). These collections of *Phoma* are phylogenetically heterogenous. The system of classification of *Phoma* anamorphs could be improved by further evaluating all known species for their phylogenetic placement and establishing monophyletic groups. A very thorough sampling of taxa and phylogenetic analysis of *Phoma* species throughout the *Pleosporales* is needed to accomplish this end. It is our conviction that much can be added to the present framework of classification of *Phoma* and *Phoma*-like states by continuing to develop an understanding of the evolutionary history of *Phoma* and related groups.

Acknowledgements

This research was supported in part by the New Jersey Agricultural Experiment Station. We are grateful to Drs. Adrian Leuchtmann and Amy Rossman for reviewing versions of this manuscript.

References

- Alexopoulos CJ, Mims CW, Blackwell M. 1996. Introductory Mycology. John Wiley & Sons, New York, NY.
- Bills GF, Christensen M, Powell M, Thorn G. 2004. Saprobiic Soil Fungi. Pages 271-302 in: Biodiversity of Fungi: Inventory and Monitoring Methods (eds Mueller G, Bills GF, Foster M). Elsevier Academic Press, New York.
- Boerema GH. 1970. Additional notes on *Phoma herbarum*. Persoonia 6: 15-48.
- Boerema GH. 1997. Contributions towards a monograph of *Phoma* (coelomycetes)—V. Subdivision of the genus in sections. Mycotaxon 64: 321-333.

- Boerema GH, De Gruyter J, Noordeloos ME, Hamers MEC. 2004. *Phoma* Identification Manual: Differentiation of Specific and Infra-Specific Taxa in Culture. CABI, The Netherlands.
- Bridge PD, Roberts PJ, Spooner BM, Panchal G. 2003. On the unreliability of published DNA sequences. *New Phytologist* 160: 43-48.
- Grondona I, Monte E, Garcia-Acha I, Sutton BC. 1997. *Pyrenochaeta dolichi*: an example of a confusing species. *Mycological Research* 101: 1405-1408.
- Grove WB. 1935. *British Stem and Leaf Fungi*. 1: 1-448.
- De Gruyter J. 2002. Contributions towards a monograph of *Phoma* (coelomycetes) IX. Section *Macrospora*. *Persoonia* 18: 85-102.
- Hawksworth DL. 2004. 'Misidentifications' in fungal DNA sequence databanks. *New Phytologist* 161: 13-14.
- Huelsenbeck JP. 2000. MrBayes: Bayesian inference of phylogeny. Distributed by the author. Department of Biology, University of Rochester, USA.
- Huelsenbeck JP, Ronquist F. 2001. MrBayes: Bayesian inference of phylogenetic trees. *Bioinformatics* 17: 754-755.
- Morgan-Jones G. 1988a. Studies in the genus *Phoma*. XIV. Concerning *Phoma herbarum*, the type species, a widespread saprophyte. *Mycotaxon* 33: 81-90.
- Morgan-Jones G. 1988b. Studies in the genus *Phoma*. XV. Concerning *Phoma multirostrata*, a leafspot-inducing and soil-borne species in warm climates. *Mycotaxon* 33: 339-351.
- Morgan-Jones G, White JF Jr. 1983. Studies in the genus *Phoma*. I. *Phoma americana* sp. nov. *Mycotaxon* 16: 403-413.
- Posada D, Crandall KA. 1988. Modeltest: testing the model of DNA substitution. *Bioinformatics* 14: 817-818.
- Punithalingam E. 1990. *Mycosphaerella zae-maydis*. C.M.I. descriptions of pathogenic fungi and bacteria 1015. *Mycopathologia* 112: 49-50.
- Rai MK. 1998. The Genus *Phoma* (Identity and Taxonomy). International Book Distributors, Dehra Dun, India.
- Reddy PV, Patel R, White JF Jr. 1998. Phylogenetic and developmental evidence supporting reclassification of cruciferous pathogens *Phoma lingam* and *P. wasabiae* in genus *Plenodomus*. *Canadian Journal of Botany* 76: 1916-1922.
- Rossman AY, Farr DF, Castlebury LA, Shoemaker R, Mengistu A. 2002. *Setomelanomma holmii* (*Pleosporales*, *Phaeosphaeriaceae*) on living spruce twigs in Europe and North America. *Canadian Journal of Botany* 80: 1209-1215.
- Saccardo PA. 1880. *Conspectus generum fungorum italiae inferiorum nempe ad Sphaeropsideas, Melanconieas et Hyphomyceteas pertinentium, systemate sporologico dispositoru*. *Michelia* 2: 1-38.
- Sullivan R, Bergen MS, Patel R, Bills GF, Alderman SC, Spatafora J, White JF Jr. 2001. Features and phylogenetic status of an enigmatic clavicipitalean fungus *Neoclaviceps monostipa* gen. et sp. nov. *Mycologia* 93: 90-99.
- Sutton BC. 1980. *The Coelomycetes*. Commonwealth Mycological Institute, Kew, Surrey, England.
- Wehmeyer LE. 1961. *A World Monograph of Genus Pleospora and Its Segregates*. University of Michigan Press. Ann Arbor.
- Swofford DL. 1999. *PAUP. Phylogenetic Analysis Using Parsimony (and Other Methods)*, Version 8. Sinauer Associates, Sunderland, Massachusetts.
- White JF Jr, Morgan-Jones G. 1986. Studies in the genus *Phoma*. V. Concerning *Phoma pomorum*. *Mycotaxon* 25: 461-466.

- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pages 315-322, in: PCR protocols: a guide to methods and applications. (eds Innis MA, Gelfand DH, Sninsky JJ, White TJ), Academic Press, Inc., San Diego, CA.

***Hypoderma qinlingense* sp. nov.
on *Sabina squamata* from China***

YING-MEI LIANG¹, CHENG-MING TIAN²,
ZHI-MIN CAO³, JUN-XIU YANG³ & MAKOTO KAKISHIMA¹

cmtian@126.com

¹ Graduate School of Life and Environmental Sciences
University of Tsukuba, Ibaraki 305-8572, Japan

² The Key Laboratory for Silviculture & Conservation of Ministry of Education
Beijing Forestry University, Beijing 100083, China

³ College of Forestry, Northwest A. & F. University
Shaanxi 712100, China

Abstract—Specimens of *Hypoderma* on *Sabina squamata* were collected during the survey of plant parasitic fungi at Mt. Qinling, Shaanxi Province, Northwest of China. Based on their morphological examinations, a new species, *H. qinlingense*, is described. This species is characterized by ascospores without gelatinous sheaths.

Key words—Ascomycete, *Rhytismatales*, taxonomy

Introduction

Since 1985, we have been investigating plant parasitic fungi on shrubs and trees at Mt. Qinling in Shaanxi Province, China. More than 5000 specimens of fungi were collected from more than 50 families of host plants, and about 480 species of fungi have been recorded from Qinling Mountains (Tian et al. 1991; Cao & Li 1999; Yang et al. 2000). Among them four specimens of an ascomycetous fungus on *Sabina squamata* (Buch.-Ham.) Antoine were collected and their morphological examinations showed that these specimens had immersed ascomata covered by the clypeus and opening by a single longitudinal split. Based on these morphological characteristics, we considered this fungus a member of *Hypoderma* De Not. (Darker 1967; Johnston 1989, 1990, 1994). When we compared the morphology of this fungus with the thirty other known *Hypoderma* species (Johnston 1990, 1991; Kirk et al. 2001; Lin et al. 2004), we found that this fungus has significant differences from previously reported species in morphological characteristics of ascomata and ascospores. Therefore, we described it as a new species.

*Contribution no. 196, Laboratory of Plant Parasitic Mycology, Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan.

Description

Hypoderma qinlingense Y.M. Liang & C.M. Tian, sp. nov.

Fig. 1

Ascocarpis sparsis in maculis griseo-brunneis, subcuticularibus, elevates, extus ellipsoideis, atris, 800 × 300 µm, fissura longitudinali dehiscentibus, labiis brunneis; clypeis fere carbonaceis, extensis ad murum inferiorem bene evolutum; ascis clavatis, stipitatis, apice subtruncatis, cum poro vel obturamento non amyloideo, 52.5-92.0 × 10.5-13.0 µm; paraphysibus apice non aut leviter inflatis, rectis vel curvatis; ascosporis ellipsoideis usque oblongo-ellipticis, paulo curvulis, hyalinis, 0-1-septatis, non constrictis, sine vaginis gelatinis, 12.0-18.5 × 4.5-6.0 µm; anamorphose ad Leptostroma sp., conidiis unicellularibus, hyalinis, bacillaribus, 4-5 × 1 µm.

Holotype here designated: on *Sabina squamata*, Mt. Taibai, alt. 3000-3300 m, Shaanxi, China, Aug 21, 1986, J. X. Yang, HMNWFC-86TB094, deposited in the Mycological Herbarium of the College of Forestry, Northwest Sci-Tech University of Agriculture and Forestry, China (HMNWFC). Isotype in the Mycological Herbarium of Beijing Forestry University (HMBFU-T0105).

Other specimens examined: on *Sabina squamata*, Mt. Taibai, Shaanxi, China, Sept 21, 1989, Tian and Yang, HMBFU-T0106, HMBFU-T0107.

Ascomata and conidiomata developing on the needle-leaves of host, in discrete scorched pale areas. These pale areas often not associated with black zone lines. In surface view ascomata 0.4-1.3 × 0.3-0.6 mm, elliptic in outline with rounded ends. Unopened ascomata with uniformly black walls. Ascomata opening by a single, longitudinal split, which is lined with a narrow, often indistinct yellow, brown, or dark brown zone. Conidiomata 0.1-0.3 mm diam., circular in outline, brown to dark brown, pustulate. Ascomata subcuticular. In vertical section, upper wall of the unopened ascomata up to 30-60 µm thick, narrower toward the edges. Wall comprising mostly brown to dark brown, angular cells, with a group of paler, thinner walled cells in the inside edges, along the fissure line of opening. In opened ascomata the upper walls up to 40-90 µm thick near the ascomatal opening, becoming either gradually or abruptly thinner towards the outer edge. Upper walls comprising dark tissue with no obvious cellular structure; cylindric, 30-50 µm long, thin-walled, hyaline to dark brown cells developing across exposed face of broken upper walls. Lower walls 15-25 µm wide, of dark brown, thick-walled cells. Paraphyses 1.5 µm diam., undifferentiated at apex, barely extending beyond asci. Asci 52.5-92.0 × 10.5-13.0 µm, clavate with basal stalk, tapering gradually to the rounded apex, walls at the apex sometimes slightly thickened and with indistinct central pore, 8-spored, spores extending two-thirds down the ascus, maturing successively. Ascospores 12.0-18.5 × 4.5-6.0 µm, slightly tapering towards rounded both ends, in side view slightly curved, 0-1-septate, without gelatinous sheath. Anamorph: conidiomata subcuticular, 0.2-0.3 mm diam., round in outline, dark brown to black, pustulate, subcuticular. Conidia 4-5 × 1 µm, oblong with rounded ends, or short-clavate, hyaline, 0-septate.

Discussion

Hypoderma are similar in many ways to some species of *Lophodermium* (Johnston 1989, 1990), but traditionally the two genera have been distinguished by the shape

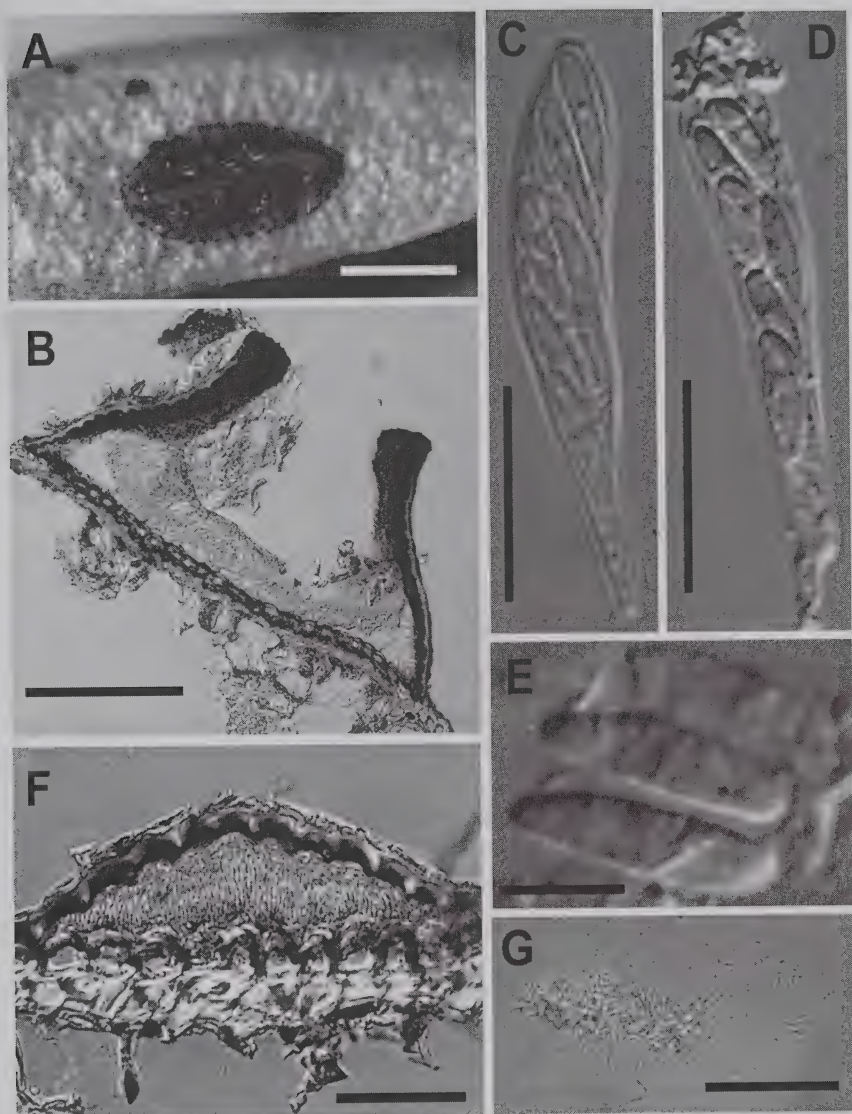


Fig.1. *Hypoderma qinlingense*. A. Ascoma on needle-leaf of *sabina squamata* (bar= 0.5 mm); B. Vertical section of ascoma (bar=150 μ m); C-D. Asci (bar=30 μ m); E. Ascospores (bar=8 μ m); F. Vertical section of conidioma (bar=80 μ m); G. Conidia (bar=35 μ m).

of ascospores which are ellipsoidal to cylindrical in the former and long filiform in the latter genus (Cannon et al. 1986). In addition, species of *Hypoderma* have clavate asci with long stalks, while those of *Lophodermium* usually have cylindrical asci with relatively short stalks (Darker 1932, 1967; Minter et al. 1984; Powell 1974; Cannon

et al. 1983, 1986). However, Johnston (1990, 1991) redefined the genus *Hypoderma*, based on nine characters associated with ascomatal development and morphology and reported 13 species from New Zealand. We considered that *H. qinlingense* was identical with these characteristics.

Hypoderma qinlingense can be distinguished from other *Hypoderma* species by ascospores without gelatinous sheaths surrounding the entire spores when they were mounted in 3-5% KOH.

In the shape of ascospores, *H. qinlingense* is very similar to *H. rubi* (Pers.) DC. ex Chevall., *H. bihospitum* P.R. Johnst., and *H. cordyline* P.R. Johnst. However, *H. qinlingense* can be distinguished from above three species by size of its asci and ascospores. Asci of *H. qinlingense* ($52.5\text{--}92.0 \times 10.5\text{--}13.0 \mu\text{m}$) are smaller than those of *H. rubi* ($110\text{--}160 \times 11\text{--}14 \mu\text{m}$), and ascospores of *H. qinlingense* ($12.0\text{--}18.5 \times 4.5\text{--}6.0 \mu\text{m}$) are also smaller than those of *H. rubi* ($15\text{--}28 \times 2.5\text{--}5.5 \mu\text{m}$). Furthermore, the ascospores of *H. qinlingense* are uniform in shape at both ends, and elliptic or oblong-elliptic. The ascospores of *H. rubi* (Johnston, 1990) are wide near the center, tapering slightly to the rounded apex, and more markedly to the acute base than those of *H. qinlingense*.

Hypoderma bihospitum and *H. cordyline* can be distinguished from *H. qinlingense* in size of asci. These species have bigger asci ($80\text{--}130 \times 11\text{--}16 \mu\text{m}$, and $90\text{--}140 \times 11\text{--}16 \mu\text{m}$, respectively) than those of *H. qinlingense*. In addition, the asci of *H. bihospitum* has no basal stalk and *H. cordyline* has bigger conidia ($5\text{--}9 \times 1 \mu\text{m}$) (Johnston, 1990) than those of *H. qinlingense* ($4\text{--}5 \times 1 \mu\text{m}$).

In addition, *H. qinlingense* is parasitic on the needle-leaves of a conifer, though above mentioned three species are saprotrophic on the fallen leaves and dead stems of broad-leaved trees.

On the other hand, *Lophodermium juniperinum* (Fr.) De Not. [= *H. juniperinum* (Fr.) Kuntze] has been reported on *Sabina squamata* by Hou and Wang (1995) in China. However, *L. juniperinum* is different from this species, which has long stalks of asci and filiform ascospores. Furthermore, asci of *H. qinlingense* are smaller than those of *L. juniperinum* ($110\text{--}130 \times 15\text{--}17 \mu\text{m}$), and ascospores of *H. qinlingense* are also smaller than those of *L. juniperinum* ($70\text{--}90 \times 2\text{--}3 \mu\text{m}$). *Lophodermium juniperinum* was found on the fallen needle-leaves of *S. squamata*.

Acknowledgments

We are grateful to Dr. Ken Katumoto (former professor of Yamaguchi University), Yamaguchi, Japan and Dr. T. Hosoya, Department of Botany, the National Science Museum, Tsukuba, Japan for critically reading the manuscript and checking Latin description.

Literature Cited

- Cannon PF, Minter DW. 1983. The nomenclatural history and typification of *Hypoderma* and *Lophodermium*. *Taxon* 32: 572–583.
 Cannon PF, Minter DW. 1986. The *Rhytismataceae* of the Indian Subcontinent. *Mycological Papers* 155: 1–123.

- Cao ZM, Li ZQ. 1999. Rust fungi of Qinling Mountains. China Forestry Publishing House: Beijing (China). pp.1-188.
- Darker GD. 1932. The *Hypodermataceae* of conifers. Contrib Arnold Arboretum. 1: 1-131.
- Darker GD. 1967. A revision on the genera of the *Hypodermataceae*. Can. J. Bot. 45: 1399-1444.
- Hou CL, Wang YZ. 1995. Investigation on the pathogenetic fungi of *Rhytismataceae* on conifers. Forest Research 8: 426-428.
- Johnston PR. 1989. *Rhytismataceae* in New Zealand 2. The genus *Lophodermium* on indigenous plants. New Zealand J Bot. 27: 243-274.
- Johnston PR. 1990. *Rhytismataceae* in New Zealand 3. The genus *Hypoderma*. New Zealand J Bot. 28: 159-183.
- Johnston PR. 1991. *Rhytismataceae* in New Zealand 4. *Pureke zelandicum* gen. and sp. nov., plus additional species in *Hypoderma*, *Lophodermium*, and *Propolis*. New Zealand J. Bot. 29: 395-404.
- Johnston PR. 1994. Ascospore sheaths of some *Coccomyces*, *Hypoderma*, and *Lophodermium* species (*Rhytismataceae*). Mycotaxon 42: 221-239.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth and Bisby's dictionary of the fungi. 9th ed. Wallingford: CAB International (UK). pp. 1-655.
- Lin YR, Wang SJ, He YF. 2004. Two new taxa of genus *Hypodroma* (*Rhytismataceae*). Mycosystema 23: 11-13.
- Minter DW, Cannon PF. 1984. Ascospore discharge in some members of the *Rhytismataceae*. Trans. Br. Mycol. Soc. 83: 65-92.
- Powell PE. 1974. Taxonomic studies in the genus *Hypoderma* (*Rhytismataceae*). Ph.D. Thesis. i-iv, 1-116. USA, New York, Ithaca; Cornell University.
- Tian CM, Cao ZM, Yang JX. 1991. Preliminary study on pathogenic fungi of forest tree and shrubs in Taibai natural protected area. Journal of Northwest Forestry University 6: 34-38.
- Yang JX, Cao ZM, Tian CM. 2000. Study report on economy fungi in Taibai natural protected area. Northwest Sci-Tech University of Agriculture and Forestry. Shaanxi (China). pp. 1-126.

***Melanogaster utriculatus* sp. nov. from Japan**

YUN WANG*

wangy@crop.cri.nz

Institute of Applied Ecology, Academia Sinica
Shenyang 110015, China

MICHAEL A. CASTELLANO

mcastellano@fs.fed.us

USDA Forest Service, Pacific Northwest Research Station
Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331

JAMES M. TRAPPE

trappej@onid.orst.edu

Department of Forest Science, Oregon State University,
Corvallis, Oregon 97331-5752

Abstract—A new *Melanogaster* species is described and illustrated: *M. utriculatus* from Japan. The relationship of the new species to other closely related species is discussed. A key to *Melanogaster* species from Asia is presented.

Keywords—Basidiomycetes, Boletales, taxonomy

Years ago the senior author visited the Forestry Sciences Laboratory, Corvallis, Oregon, USA to work on taxonomy of *Melanogaster* under the tutelage of Dr. J. M. Trappe. Examination of all available *Melanogaster* specimens in numerous herbaria from around the world revealed five new *Melanogaster* species from Asia. The senior author has described three of them with Chinese colleagues (Wang et al. 1995), these being *Melanogaster spinisporus* and *M. ovoidisporus* from China and *M. fusisporus* from China and Japan. A new species, *M. utriculatus* from Japan is described and illustrated in this paper. The type collection is deposited in OSC (Holmgren & Keuken 1974).

Melanogaster utriculatus* Y. Wang, Castellano & Trappe sp. nov.*Figs 1-2**

Basidiomata dessicata usque ad 3 cm in diam, subglobosa, irregularia vel rugosa. *Peridium* brunneum, 300–400 µm crassum, minute tomentosum, basi rhizomorphis appressis, stratis duobus: epicutis hyphis intertextis croceis, 2–4 µm crassis; subcutis hyphis armeniis, 5 µm crassis, cellulis inflatis usque ad 10–15 µm. *Gleba atra* venis avellaneis. *Sporae* laeves, (9-) 11–15 (-17) x (7-) 8–11 µm, late ellipsoideae

*Permanent address: Crop & Food Research, Invermay Agricultural Center, Private Bag 50034, Mosgiel, New Zealand.

vel obovoideae, utriculo hyalino, rugoso inclusae, singulatim obscure brunneae, aggregatae atrobrunneae.

Holotypus hic designatus: leg. N. Sagara (OSC Yoshimi #2237), Honshu, Kyoto, Iwakara, Japan, 24 October 1970.

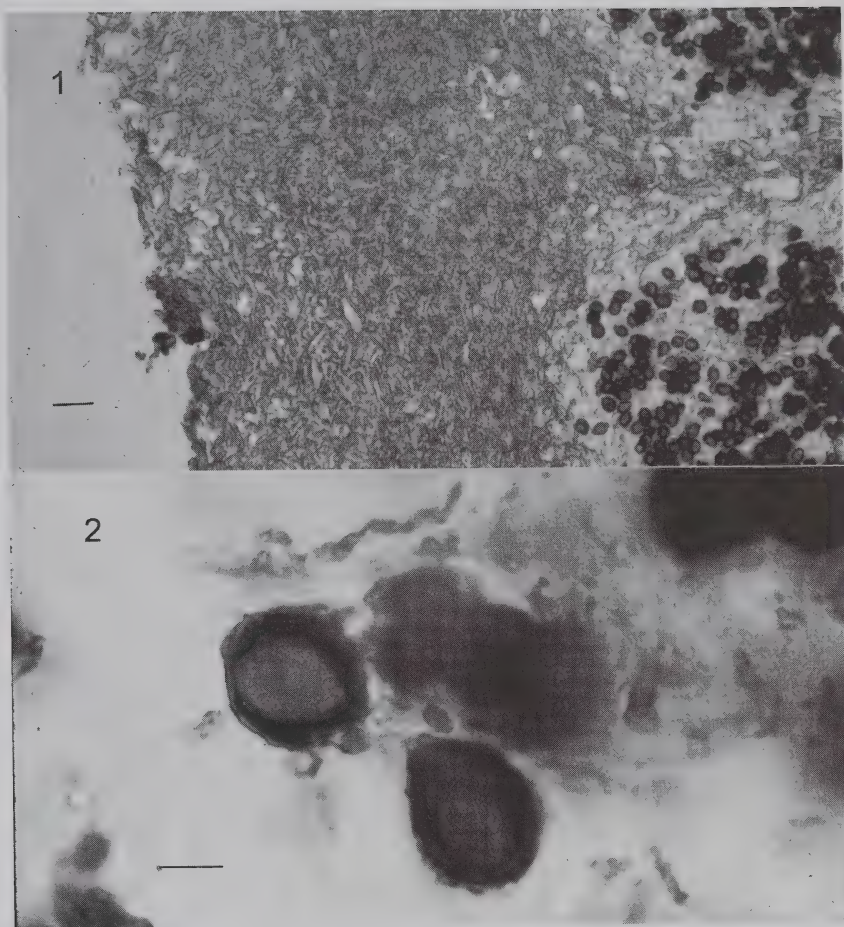
Etymology: Latin, referring to the utriculate spores.

Sporocarp up to 3 cm in diam, subglobose, irregular to wrinkled, deep brown, minutely tomentose when dried; rhizomorphs concolorous, abundant and appressed at base. **Gleba** black, firm, hard when dried, marbled with pale brown trama; the locules rounded or irregular, filled with spores embedded in gelatinous matrix at maturity. **Peridium** up to 300-400 μm thick, two-layered: epicutis exuding a brown pigment in KOH, 15-20 μm thick of pale yellow-brown, thin-walled, compactly interwoven hyphae, 2-5 μm in diam; clamp connections abundant; subcutis 280-380 μm thick, of deep orange-yellow, thin-walled, interwoven hyphae, 2-5 μm in diam with many cells inflated 10-15 μm ; clamp connections present. **Trama** of pale orange-yellow, interwoven hyphae, 4 μm in diam, with round inflated cells up to 10 μm in diam. **Spores** smooth, bilaterally symmetric, enclosed in a smooth to wrinkled, slightly inflated, or partially ephemeral utricle, (9-) 11-15 (-17) $\times$ (7-) 8-11 μm , broadly ellipsoid to obovoid, pyriform or subglobose; the base truncate-cupped, 2-2.5 μm in diam; walls 1-1.5 μm thick; in KOH dark brown singly, black-brown in mass; not distinctive in Melzer's reagent; utricle 0.5 μm thick but appearing thicker or inflated; **Basidia:** rehydrating poorly, hyaline, sphaeropedunculate, 4-spored, gelatinized at maturity.

On most spores of the holotype the utricle is smooth and tightly appressed to the spore wall, thus appearing to be the outer layer of a double wall. On some spores, however, it becomes wrinkled or inflated away from the spore wall, being revealed thereby as a true utricle. On apparently older spores the utricle flakes away. No other *Melanogaster* species has been described as having utriculate spores.

Key to species of *Melanogaster* from Asia

1. Spores spiny or with utricle 2
1. Spores smooth 3
2. Spores minutely spiny *M. spinisporus*
2. Spores with appressed or inflated utricle *M. utriculatus*
3. Spores fusoid; basidia with 2-4 spores. 4
3. Spores not fusoid; basidia with 4-8 spores 6
4. Spores longer than 13 μm long *M. trappei*
4. Spores shorter than 13 μm long 5
5. Peridium prosenchymatic, spores (8-) 10-11 (-15) $\times$ 6.5-7 (-9) μm *M. natsii*
5. Epicutis prosenchymatic, subcutis pseudoparenchymatous, spores (10-) 11.5-13(-15) $\times$ (5-) 5.5-6 (-6.5) μm *M. fusisporus*
6. Spores subglobose to globose, 8-10 (-11) $\times$ 7-8 (-9) μm *M. subglobosporus*
6. Spores ovoid, (5-) 5.5-6.5 (-7) $\times$ (3.5) 4-5 (-5.8) μm *M. ovoidisporus*



Figs. 1-2. *Melanogaster utriculatus* (Yoshimi #2237). **Fig. 1.** Peridial section, bar = 32 μm .

Fig. 2. Spores, bar = 6 μm .

Acknowledgements

We appreciate the review comments of Drs. E. Cázares, R. Halling, and T. Lebel. We are indebted to herbaria cited for loan of specimens as well as these individuals: S. Yoshimi and Dr. N. Sagara, Kyoto, Japan. This study was supported by the Chinese Academy of Sciences, China.

References

- Holmgren PK, Keuken W. 1974. Index Herbarium. Part I. The Herbaria of the world. 397 pp.
 Wang Y, Chang MC, Tao K, Liu B. 1995. New species and new varieties in the genus *Melanogaster* from China. *Journal of Shanxi University (Natural Science Edition)*, 18(4): 449-453.

A study of wood decaying macrofungi of the western Black Sea Region, Turkey

AHMET AFYON¹, MUHSIN KONUK², DURSUN YAĞIZ¹
& STEPHAN HELFER³

¹*aafyon@selcuk.edu.tr dyagiz@selcuk.edu.tr*
Selcuk University, Education Faculty
42099, Meram, Konya-TURKEY

²*mkonuk@aku.edu.tr*
Afyon Kocatepe University, Faculty of Art and Science
Afyonkarahisar-TURKEY

³*s.helfer@rbge.org.uk*
Royal Botanic Garden Edinburgh
20A Inverleith Row, Edinburgh EH3 5LR, U.K.

Abstract — This study was based on specimens of macrofungi collected on field trips to the region between 1998 and 2000. A list of 80 species belonging to *Ascomycotina* and *Basidiomycotina* has been compiled and 7 species were added to the Turkish mycoflora as new records. The complete checklist to species can be viewed on the RBGE website : <http://rbg-web2.rbge.org.uk/mycotaxon/50428.pdf>.

Key words — lignicolous, saprophytic, parasitic

Introduction

Since the western Black Sea Region has a mild oceanic climate, wood-decaying fungi can be found throughout the year. Coniferous broad leaf forests cover large areas of the region, providing good growing conditions and substrate for wood rotting fungi. Trees growing in sheltered valleys and near streams are particularly suitable habitats for these fungi. A list of wood decaying fungi from Turkey has been published by Baytop (1994). Other studies were carried out by a number of workers in various parts of Turkey (Pilat 1932, 1933; Lohwag 1957, 1964; Selik 1973; Kotlaba 1976; Sümer 1977, 1982; Abatay 1983, 1985). One of these studies (Sümer 1982) also covered parts of the western Black Sea Region, especially Bolu district. Because of the ecological properties of the area and the scarcity of data, especially in respect of wood decaying macrofungi, we decided to carry out a detailed study to determine the occurrence and distribution of these organisms in the entire western Black Sea Region. The area consists of seven provinces (Bolu, Düzce, Karabük, Kastamonu, Sinop, Zonguldak, and Bartın; see fig. 1), and represents the largest study area of this kind in Turkey to date. It was also intended to make a contribution to the mycoflora of Turkey as a whole.

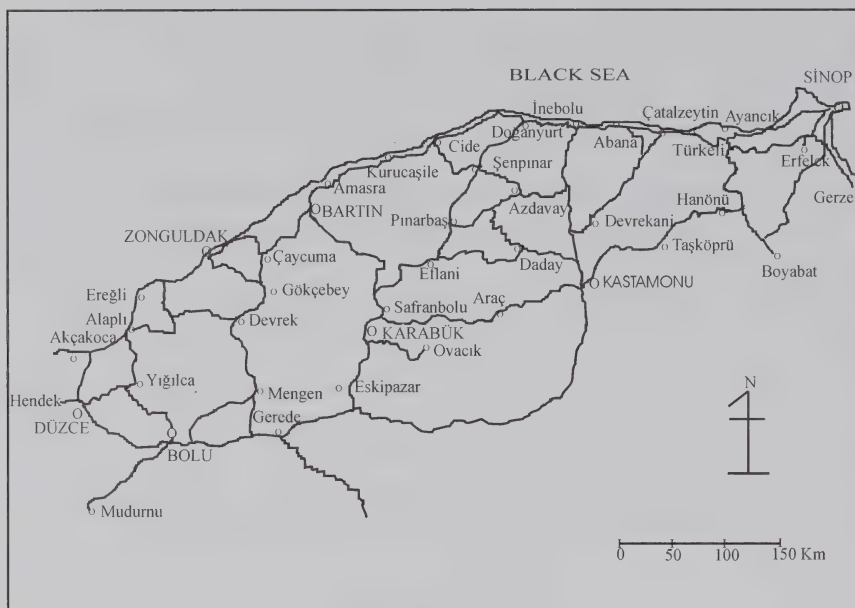


Figure 1: Map of the study area.

Materials and Methods

Specimens were collected during field work 1998-2000. The morphological properties and ecological conditions of the specimens were recorded in the field, and samples were taken to the laboratory for microscopical examination and the preparation of herbarium voucher specimens. We used the following literature for identification: Phillips (1981), Marchand (1971-1986), Breitenbach & Kränzlin (1984-1991), Michael et al. (1983-1988), and Dähncke (1993). Voucher specimens are kept at Selçuk University, Education Faculty Herbarium (KNYA).

Results

Our study recovered 80 species of wood decaying fungi. Of these 25 were recovered from coniferous trees, 51 from broadleaved trees, and 3 from either broadleaved or coniferous trees and one from litter. A total of 11 species were identified as primary parasites. Particularly rare and unusual findings were: *Hericium erinaceus*, *Trametes gibbosa*, *Crucibulum laeve*. Conversely, *Schizophyllum commune* was the most common species. *Armillaria borealis*, *Lentaria delicata*, *Pholiota lenta*, *Pluteus tricuspidatus*, *Pl. umbrosus*, *Tremella encephala* and *Xerula pudens* are new records for the Turkish mycoflora.

Discussion

This study recovered 80 species of wood decaying macrofungi from the western Black Sea Region of Turkey. They belong to the two divisions Ascomycotina (2 species) and

Basidiomycotina (78 species). Several species were living on dead tree-stumps, trunks, branches, leaf or needle litter and are decaying them. This contributes significantly to nutrient recycling in nature. Some live as parasites on live trees and cause organic product loss and structural damage to host trees. *Armillaria mellea*, *A. ostoyae*, *A. tabescens*, *Fomes fomentarius*, *Ganoderma lucidum*, *Fomitopsis pinicola*, and *Lenzites betulina* are particularly important as parasitic species. Similar studies in neighbouring regions have shown comparable findings with the data obtained in this study. Previous to this study the following species had been reported from the area and neighbouring regions: Lohwag (1964) reported *Stereum*, *Ganoderma* and *Phellinus* species from Belgrad forest. Sümer (1982) reported *Stereum*, *Ganoderma*, *Polyporus*, *Trametes* and *Mycena* species from the western Black Sea Region as wood decaying species. Abatay (1983) recorded *Trametes*, *Polyporus*, and *Stereum* species as wood parasites from the eastern Black Sea Region. He (1988) also reported some other species such as *Armillaria*, *Pholiota* and *Polyporus* species growing in different ecological conditions. Niemelä and Uotila (1977) reported some lignicolous fungi on wood in Turkey. Allı and Işiloğlu (2000) reported 34 parasitic macrofungi in Muğla province. Although previous reports agree with our findings, they were not as detailed as our research. Furthermore, our research area is larger than that of other researchers, consequently contributing more records.

The wood decay fungi *Pleurotus ostreatus* and *P. pulmonarius* are known as edible mushrooms that are collected and consumed by local people. The other edible wood-decay fungi are not recognised or valued locally.

With this study, seven wood-decay species are added to the Turkish mycoflora as new records.

Acknowledgments

The authors wish to thank TUBITAK (Turkish Scientific and Technical Research Council) for supporting this project (TBAG-1659) financially and Prof Işiloğlu for reviewing this article.

Literature Cited

- Abatay M. 1983. Doğu Karadeniz Yöresinde Odunsu Bitkilere Arız Olan Mantar Türleri Üzerine Araştırmalar. Ormançılık Araştırması Enstitüsü Yayınları Teknik Bülteni, Seri No: 114-118.
- Abatay M. 1985. Orta ve Doğu Karadeniz Bölgesinde Bulunan Odun Tahrıpçisi Mantarlar. IV. Türkiye Fitopatoloji Kongresi, İzmir.
- Abatay M. 1988. Değişik Ekolojilerde Olanda Gelişebilen Yenilebilir Fungus Türleri Üzerine Araştırmalar. V. Türkiye Fitopatoloji Kongresi, Antalya.
- Allı H, Işiloğlu M. 2000. The parasite macrofungi of Muğla Province. Ot Sistematik Botanik Dergisi. 7.1.249-255
- Baytop A. 1994. Türkiye'nin Makrofungusları ile İlgili Bir Yayın Listesi. Tr. J. Botany. 18: 175-185.
- Breitenbach J, Kränzlin F. 1984-1991. Fungi of Switzerland. Verlag Mycologia, Switzerland: Vols. 1-3.
- Dähncke RM. 1993. 1200 Pilze in Farbfotos. Aarau-Stuttgart, AT Verlag.
- Kotlaba F. 1976. Contribution to the Knowledge of the Turkish Macromycetes. Ceska Mykologie. 30: 156-169.

- Lohwag K. 1957. Ein Beitrag zur Pilzflora der Türkei. Istanbul Üniversitesi Orman Fakültesi Dergisi Seri A, 7(1): 129-137.
- Lohwag K. 1964. Belgrad Ormanından Mikolojik Notlar. İstanbul Üniversitesi Orman Fakültesi Dergisi Seri B, 14(2): 128-135.
- Marchand A. 1971-1986. Champignons du Nord et du Midi. Vol, 1-9. Société Mycologique des Pyrénées Méditerranéennes, Perpignan.
- Michael E, Hennig B, Kreisel H. 1983-1988 Handbuch für Pilzfreunde. Vol 1-6. Stuttgart, Gustav Fischer Verlag.
- Niemalä T, Uotila P. 1977. Lignicolous macrofungi from Turkey and Iran. Karstenia 17: 33-39.
- Phillips R. 1981. Mushrooms and other Fungi of Great Britain and Europa. London, Pan Books Ltd.
- Pilat A. 1932. Contribution à l'étude des Hyménomycètes de L'Asie Mineure. Bull. Soc. Mycol. France 48: 162-189.
- Pilat A. 1933. Additiamenta ad Flora Asiae Minoris Hymenomycetum. Bull. Soc. Bot. France 49: 34-77.
- Selik M. 1973. Doğu Karadeniz Bölgesi Özellikle Trabzon Civarında Odun Tahripçisi Mantarlar, İstanbul Üniversitesi Orman Fakültesi Yayınları, Seri A, 23 (2): 27-38.
- Sümer S. 1977. Belgrad Ormanındaki Ağaçlarda Çürüklük Doğuran Önemli Mantarlar, İstanbul Üniversitesi Orman Fakültesi Yayınları, No: 2339/244.
- Sümer S. 1982. Batı Karadeniz Bölgesi Özellikle Bolu Çevresinde Bulunan Odun Tahripçisi Mantarlar. İstanbul Üniversitesi Yayınları, No: 2907 / 312.

The species of *Entyloma* (Ustilaginomycetes) on *Convolvulaceae*

MARCIN PIĄTEK

mpiatek@ib-pan.krakow.pl

Department of Mycology, W. Szafer Institute of Botany,

Polish Academy of Sciences

Lubicz 46, PL-31-512 Kraków, Poland

Abstract—The species of *Entyloma* on *Convolvulaceae* are reviewed. *Entyloma convolvuli* on *Calystegia soldanella* is known only from type locality in Portugal, Europe. *Entyloma martindalei* is proposed as a new combination based on *Protomyces martindalei* described from hypertrophied clusters of flowers and enlarged stems of *Cuscuta gronovii* in North America. The name *Protomyces martindalei* is lectotypified. A key to *Entyloma* species on *Convolvulaceae* is provided.

Key words—smut fungi, taxonomy, *Protomycetaceae*

Introduction

The species of the genus *Entyloma* de Bary are characterized by sori that form spots, rarely swellings, in various vegetative parts of dicotyledonous host plants such as leaves and stems. The hyaline, yellow or pale brown spores are arranged singularly or agglutinated in irregular groups, and usually have smooth walls of various thickness. Nearly half of the known *Entyloma* species occur on representatives of *Asteraceae*. The remaining families are parasitized by fewer species, respectively (Begerow et al. 2002).

The sole known species of *Entyloma* on *Convolvulaceae* was *Entyloma convolvuli* on *Calystegia soldanella*. However, recent examination of type specimens of *Protomyces martindalei* Peck on *Cuscuta gronovii* revealed characters of the genus *Entyloma*. It is not surprising because in the past many species described as *Protomyces* Unger turned out to be smut fungi, some examples follow: *P. ari* Cooke is *Melanustilospora ari* (Cooke) Denchev, *P. endogenus* Unger is *Melanotaenium endogenum* (Unger) de Bary, *P. calendulae* Oudem. is *Entyloma calendulae* (Oudem.) de Bary, *P. fergussonii* Berk. & Broome is *E. fergussonii* (Berk. & Broome) Plowr. and *P. microsporus* Unger is *E. microsporum* (Unger) J. Schröt.

The genus *Cuscuta* L. is sometimes included in the separate family *Cuscutaceae* but usually it is treated as member of the *Convolvulaceae*. The two currently known *Entyloma* species on the *Convolvulaceae* are described as follows:

Taxonomy

Entyloma convolvuli Bres.

in Torrend, Broteria 4: 211. 1905.

Type on *Convolvulus soldanella* L. [= *Calystegia soldanella* (L.) Roem. & Schult.], Portugal, near Setubal, Serra da Arrabida, Vale de Pixaleiro, *C. Torrend* (type ubi?).

Sori in leaves as orbicular to oblong spots, reddish on the lower surface and paler red on the upper surface, reddish-brown on the margins. Spores intercellular, globose, yellowish, mostly 14–15 μm in diameter; wall thin, brownish, not layered. Mycelial hyphae hyaline to straw-yellow, ramified, 1.5 μm wide. Anamorph not seen.

On *Convolvulaceae*: *Calystegia soldanella* (= *Convolvulus soldanella*). Known only from the type locality in Portugal.

COMMENTS — Vánky (1994: 88) did not find the type specimen in any of the major herbaria in Portugal, and he composed the description of this species from the original description by Bresadola (in Torrend 1905) and from the description by Zundel (1953: 244). The description of Vánky (1994: 88) is given here.

Entyloma martindalei (Peck) Piątek, **comb. nov.**

FIGURES 1–2

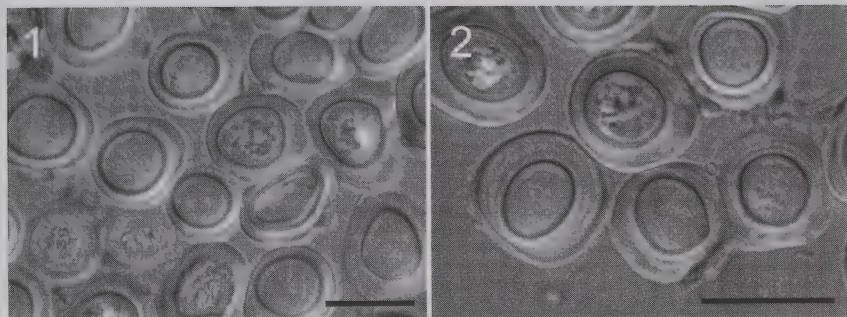
Basionym: *Protomyces martindalei* Peck, Bull. Torrey Bot. Club 5: 2-3. 1874.

Type on *Cuscuta gronovii* Willd. ex Roem. & Schult., U.S.A., New Jersey, near Camden, autumn, J. C. Martindale [lectotype (*hic designatus*): NYS!; isolectotypes: NYS!, BPI n.v.].

Sori in much hypertrophied, pale clusters of flowers and also in much enlarged parts of the stems, filled by whitish coloured mass of spores. Spores numerous, intercellular, globose, subglobose, commonly irregular, (17–)18–20(–24) $\times$ (15–)17–19(–22) μm , hyaline or yellowish, adhering in irregular groups, sometimes covered by hyaline gelatinous layer; wall smooth, thick, often unequal, 3–5 μm wide, thickest at the angles, even up to 10 μm wide, sometimes with short hyphal remains. Anamorph not seen.

On *Convolvulaceae*: *Cuscuta gronovii*. Known only from the type collections in the U.S.A.

COMMENTS — This species has been described by Peck (1874) as *Protomyces martindalei* based on specimens collected by J. C. Martindale near Camden in New Jersey, U.S.A. Reddy and Kramer (1975) in their monograph of *Protomycetales* excluded this species from this group because “spores are too small (18 μ) for *Protomyces*, and the host, *Cuscuta gronovii* appears unlikely for *Protomycetaceae*”. Nevertheless, they did not propose any other genus for this species. The morphological features of spores, they shape and size are characteristic for the genus *Entyloma*. Accordingly, its transfer to this genus is proposed. It should be noted that the spores of *E. martindalei* are large in comparison with most other species of *Entyloma*, which have smaller spores, usually no more than 15 μm in diameter. However, there are several species in *Entyloma*, which have at least some percentage of spores exceeding 20 μm in diameter, some examples are *Entyloma magnusii* (Ule) Woronin, *E. microsporum* and *E. sonchi* Vánky (Vánky 1994).



Figs 1–2. Spores of *Entyloma martindalei* on *Cuscuta gronovii*, in LM (lectotype: NYS).
Bars = 20 μm .

In his protologue for *Protomyces martindalei*, Peck (1874) did not select a type specimen. Charles H. Peck's collection is preserved in NYS where there are two specimens of *Protomyces martindalei*, bearing almost identical labels. One of them is marked as "type" and the other as "?isotype" but the handwriting and shade of pencil differ from the remaining part of the labels, and it appears that these words were written later. The former specimen is here chosen as the lectotype since it is more abundant and marked as "type", and the latter specimen as an isolectotype. The other isolectotype is probably preserved in BPI because the specimen identified as *Protomyces martindalei* is included in the "specimens database" of this herbarium (<http://nt.ars-grin.gov/fungaldatabases/specimens/specimens.cfm>) with almost identical data as in the protologue (the only exception is presence of the date in the collection in BPI: September 1873), but this specimen was not seen during the present study.

Key to the *Entyloma* species on *Convolvulaceae*

1. Spores about 14–15 μm in diameter, wall thin. On *Calystegia* *E. convolvuli*
- 1* Spores about 17–20 μm in diameter, wall thick. On *Cuscuta* *E. martindalei*

Acknowledgements

I am grateful to Dr. Kálmán Vánky (Tübingen, Germany) and to Dr. Roger G. Shivas (Indooroopilly, Australia) for reading the manuscript, their useful suggestions and serving as pre-submission reviewers, to the Curator of NYS for loan of smut fungus specimens, and to Dr. Lorinda Leonardi (New York, U.S.A.) for help in obtaining important literature. This study was supported by the Ministry of Science and Information Society Technologies in Poland (MNIł) for the years 2005–2007, grant no. 2 P04G 019 28.

Literature Cited

- Begerow D, Lutz M, Oberwinkler F. 2002. Implications of molecular characters for the phylogeny of the genus *Entyloma*. *Mycol. Res.* 106(12): 1392–1399.
- Peck CH. 1874. Two new fungi from New Jersey. *Bull. Torrey Bot. Club* 5: 2–3.

- Reddy MS, Kramer CL. 1975. A taxonomic revision of the *Protomycetales*. Mycotaxon 3(1): 1-50.
- Torrend C. 1905. Terceira contribuição para o estudo dos fungos a Região Setubalense. Broteria 4: 207-211.
- Ványk K. 1994. European smut fungi. G. Fischer Verlag, Stuttgart-Jena-New York.
- Zundel GL. 1953. The *Ustilaginales* of the world. Pennsylvania State Coll. School Agric. Dept. Bot. Contrib. 176: xi + 1-410.

Three new rust species (*Uredinales*) from Turkey

ZELIHA BAĞÇECİOĞLU, SANLI KABAKTEPE

zbahcecioglu@inonu.edu.tr skabaktepe@inonu.edu.tr

Inonu University, Science and Art Fac., Department of Biology
Malatya, Turkey

& BAYRAM YILDIZ

byildiz@balikesir.edu.tr

Balikesir University, Science and Art Fac., Department of Biology
Malatya, Turkey

Abstract—This paper describes and illustrates three new rust species, *Phragmidium hendersonii* on *Potentilla*, *Puccinia gjaerumii* on *Bellardiochloa polychroa* and *Puccinia asyneumatis* on *Asyneuma amplexicaule*.

Keywords—microfungi, new taxa, parasite

Introduction

Approximately three hundred and twenty rust fungi are known in Turkey (Bağçecioğlu 1998, 2001; Bağçecioğlu & Isıloğlu 1995; Bağçecioğlu & Gjørsum 2003, 2004; Kabaktepe & Bağçecioğlu 2005; Bağçecioğlu & Yıldız 1996, 2005; Henderson 1959, 1961, 1964; Tamer et al. 1998). With this new study, three new rusts have been added to the Turkish rust flora.

Materials and methods

Specimens cited here were collected in the years 2002–2004 in Kahramanmaraş and Ordu provinces. Spores were mounted in lactophenol. Host names follow the “Flora of Turkey and Aegean Islands” by Davis (1968–1985) and Davis et al. (1988). The specimens are preserved in the herbarium of İnönü University.

Phragmidium hendersonii Bağç. & Kabaktepe, sp. nov.

Fig. 1

Etymology: in honour of Prof. Dr. D.M. Henderson.

Pycnia et aecia ignota. Uredinia hypophylla, dispersa, brunnea. Urediniosporae 18–30 x 16–20 µm, globoideae, ellipsoideae, vel ovoideae, pariete 1–2 µm crasso, luteolo, verruculoso, cum 3 poris germinationis dispersis. Telia urediniis similia, sed atra, cum paraphysibus clavatis, pariete 1–1.5 µm crasso, hyalino. Teliosporae 44–110 x 20–26 µm, 3–7 cellulares (raro 1–2), cylindraceae, ad septum leviter constrictae, basim versus rotundatae, quoque cellula aequalis, ad apicem dilatatae, generaliter praecipue apice

obtusae papillatae, pariete laevi, 2-3 μm crasso, castaneo-brunneo, quoque cellula poro 1 (raro 2), pedicello persistenti, usque ad 220 μm longo, deorsum incrassato vel non, hyalino vel dimidiis colorato.

Pycnia and aecia not seen. Uredinia hypophyllous, scattered, brown. Urediniospores 18-30 x 16-20 μm , globoid, ellipsoid, ovoid, wall 1-2 μm thick, yellow, verruculose with 3 scattered pores. Telia similar to uredinia, but black, with clavate paraphyses, walls 1 μm thick, hyaline. Teliospores 44-110 x 20-26 μm , 3-7 (rarely 1-2) celled, cylindric, slightly constricted at the septa, rounded at base, cells almost equal in size except for the larger uppermost one, generally bluntly papillate at apex, rarely absent, wall smooth, 2-3 μm thick, chestnut brown, with 1 (rarely 2) pore upper part of each cell. Pedicel up to 220 μm long, of equal thickness or swelling at base, upper part pigmented, at base hyaline or slightly pigmented.

Holotype here designated: Z. Bahçecioglu 3830 (Inönü), Turkey, Kahramanmaraş, 2-3 km from Andırın to Cıgırsar, 1300 m, 20. Aug. 2004, on *Potentilla* sp. (*Rosaceae*). Isotype in NCRI.

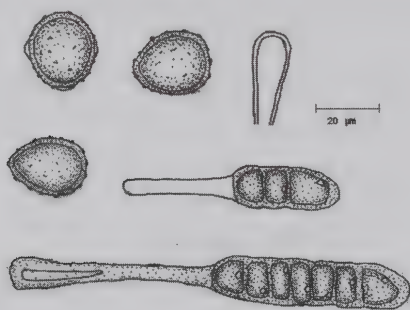


Fig. 1. *Phragmidium hendersonii*. Telio-, urediniospores and paraphysis from type.

The teliospores in the present specimen differ from those in *Phr. potentillae* (Pers.) P. Karst. by having 7 cells, each with 1 pore (rarely 2), by being slightly constricted at septum and the bigger size.

Phr. potentillae has been reported on the present host from America, Finland, Germany, Great Britain, Italy and Turkey.

***Puccinia asyneumatis* Bahç. & Kabaktepe, sp. nov.**

Etymology: from *Asyneuma*, a genus in Campanulaceae.

Fig. 2

Pycnia et aecia ignota. Uredinia hypophylla, rariter epiphylla, dispersa, pulverulenta, brunnea. Urediniosporae 20-28 x 18-22 μm , globoideae, ellipsoideae, pariete 1.5-2.5 μm crasso, cinnamomeo-brunneo echinulato, cum 2-4 poris germinationis dispersis. Telia urediniis similia. Teliosporae 26-34 x 16-20 μm , ellipsoideae, oblongus, rariter basim versus attenuatae, ad septum leviter constrictae, pariete 1-2 μm crasso, brunneo, leviter verruculoso, poro superiore apicali, poro inferiore prope septum, poris hyalinis papillis tectis, pedicello hyalino, fragili.

Pycnia, aecia not seen. Uredinia hypophyllous, rarely epiphyllous scattered, pulverulent, brown. Urediniospores $20\text{--}28 \times 18\text{--}22 \mu\text{m}$, globoid, ellipsoid, wall $1.5\text{--}2.5 \mu\text{m}$ thick, cinnamon brown, echinulate with 2-4 scattered pores. Telia similar to uredinia. Teliospores $26\text{--}34 \times 16\text{--}20 \mu\text{m}$, ellipsoid, oblong, rounded at both ends or rarely attenuate at base, slightly constricted at septa, wall $1\text{--}2 \mu\text{m}$ thick, brown, slightly verruculose, upper pore apical, lower pore at septa, with a minute hyaline papilla at apex, pedicel hyaline, fragile.

Holotype here designated: Sanli Kabaktepe 2441 (Inönü), Turkey, Ordu, 10 km. from Mesudiye to Golkoy, 1150 m, 05. Jul. 2003, on *Asyneuma amplexicaule* (Willd.) Hand.-Mazz. (*Campanulaceae*). Isotype in NCRI.

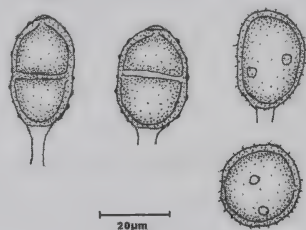


Fig. 2. *Puccinia asyneumatis*. Telio- and urediniospores from type.

To our knowledge no *Puccinia* has previously been described on this host genus. The teliospores of the present species are similar to those in *P. campanulae* Carmich. but have a dark coloured teliospore wall and urediniospores.

Puccinia gjaerumii Bahç. & Kabaktepe, sp. nov.

Etymology: in honour of Dr. Halvor B. Gjørum.

Fig. 3

Pycnia et aecia ignota. Uredinia hypophylla, rariter epiphylla dispersa, pulverulenta, aparaphysata, brunnea. Urediniosporae $22\text{--}26 \times 18\text{--}22 \mu\text{m}$, *globoideae vel subgloboideae, pariete* $2\text{--}4 \mu\text{m}$ *crasso, luteolo, verruculoso, cum* 2-3 *poris germinationis aequatorialibus vel subaequatorialibus. Telia urediniis similia sed atro-brunnea. Teliosporae* $28\text{--}40 \times 18\text{--}24 \mu\text{m}$, *ellipsoideae, basim versus rariter attenuatae, ad septum leniter vel non constrictae, pariete* $1.5\text{--}3 \mu\text{m}$ *crasso, apice usque ad* $6 \mu\text{m}$, *luteolobrunneo, laevi, poro superiore apicali, poro inferiore prope septum, apicaliter inconspicue papillato pedicello hyalino vel luteolo, persitenti, usque ad* $90 \mu\text{m}$ *longo, sporae unicellulares* $20\text{--}24 \times 16\text{--}20 \mu\text{m}$, *subgloboideae, pedicello usque ad* $34 \mu\text{m}$ *longo, hyalino.*

Pycnia, aecia not seen. Uredinia hypophyllous, rarely epiphyllous, scattered, pulverulent, lacking paraphyses, brown. Urediniospores $22\text{--}26 \times 18\text{--}22 \mu\text{m}$, globoid or subgloboid, wall $2\text{--}4 \mu\text{m}$ thick, yellowish, verruculose, with 2-3 equatorial or subequatorial pores. Telia similar to uredinia but dark brown, teliospores $28\text{--}40 \times 18\text{--}24 \mu\text{m}$, ellipsoid, oblongrounded at both ends or rarely attenuate at base, slightly constricted at septa or not wall $1.5\text{--}3 \mu\text{m}$ thick, at apex up to $6 \mu\text{m}$, yellowish brown, smooth, upper pore apical, lower pore at septa, slightly papillate. Pedicel hyaline or yellowish, persistent, up to $90 \mu\text{m}$. One-celled spores $20\text{--}24 \times 16\text{--}20 \mu\text{m}$, subgloboid, pedicel up to $34 \mu\text{m}$, hyaline.

Holotype here designated: S. Kabaktepe 2028 (Inönü), Turkey, Ordu, 8 km. from Kabatas to Catalpınar, 550 m, 18. Sep. 2002, on *Bellardiochloa polychroa* (Trautv.) Roshev. (*Poaceae*). Isotype in NCRI.

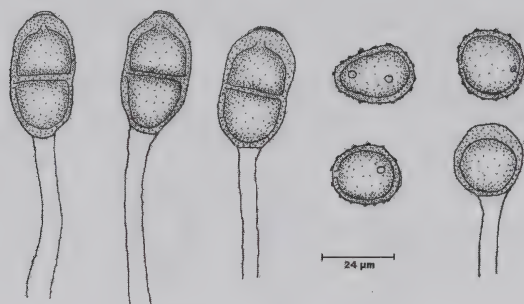


Fig. 3. *Puccinia gjaerumii*. Telio- urediniospores and mesospore from type.

To our knowledge, no rust has previously been described on this genus. The teliospores differ from those of *Puccinia molinia* Tul. by teliospores slightly constricted and with hyaline apical papillae.

Acknowledgements

We are indebted to Dr. Halvor B. Gjørsum, Planteforsk, Norwegian Plant Protection Centre, Ås Norway and Dr. Reinhard Berndt, ETH Zürich, Switzerland, for helpful suggestions.

References

- Bahçecioğlu Z, Işıloğlu M. 1995. Parasitic fungi of Malatya Province (East Anatolia). – Proc. IVth Symposium on plant life in Southwest and Central Asia. I: 414- 426.
- Bahçecioğlu Z, Yıldız B. 1996. İnönü Üniversitesi Herbaryumunda Bulunan Vasküler Bitkiler Üzerinde Tespit Edilen Parazit Funguslar. – XIII Ulusal Biyoloji Kongresi 17-20 Eylül 1996. İstanbul. (Engl. summary).
- Bahçecioğlu Z. 1998. Contributions to the Mycobiota of Turkey-Three New Records of *Puccinia* for Turkey. – Pl. Dis. Res.13(2): 215-217.
- Bahçecioğlu Z. 2001. New records of Pucciniaceae from Turkey. – Plant Dis. Res. 16: 17-22.
- Bahçecioğlu Z, Yıldız B. 2001. Malatya Yöresi Tarla Yabancı Otlar Üzerinde Belirlenen Parazit Funguslar. – C.U. Fen – Edebiyat Fakültesi, Fen Bilimeri Dergesi 22-1/ 2001. (Engl. summary).
- Bahçecioğlu Z, Gjørsum HB. 2003. New and rare rust fungi (*Uredinales*) from Anatolia (Turkey). – Mycotaxon 85: 165-173.
- Bahçecioğlu Z, Gjørsum HB. 2004. New and Rare Rust Fungi (*Uredinales*) from Anatolia (Turkey)- 2. – Mycotaxon. 90(1): 55-68.
- Bahçecioğlu Z, Yıldız B. 2005. A study on the microfungi of Sivas Province. – Turkish J. Bot. 29: 23-44.
- Davis PH (ed.) (1965-1985). Flora of Turkey and the East Aegean Islands, Vol. 1-9, Edinburgh: University Press.

- Davis PH, Mill RR, Tan Kit (eds.) (1988). Flora of Turkey and the East Aegean Islands (supplement), Vol. 10, Edinburgh: University Press.
- Henderson DM. 1959. *Uredinales* from S. W. Asia. – Notes R. Bot. Gard. Edinburgh 23: 71-83.
- Henderson DM. 1961. *Uredinales* from S. W. Asia: II. – Notes R. Bot. Gard. Edinburgh 24: 249-258.
- Henderson DM. 1964. *Uredinales* from S. W. Asia: III. The rust fungi of Turkey. – Notes R. Bot. Gard. Edinburgh 25: 197-277.
- Kabaktepe Ş, Bahçecioğlu Z. 2005. Seven rust species recorded as new to Turkey. – Mycotaxon 91: 393-397.
- Tamer AU, Şahin N, Uğurlu E. 1998. Türkiye’de Belirlenen Pas Mantarları. – XIV Ulusal Biyoloji Kongresi 7-10 Eylül 1998. Samsun. Vol. 1, 395-408 (Engl. summary).

Plenodomus morganjonesii* sp. nov. and a discussion of the genus *Plenodomus

MONICA S. TORRES¹, MARSHALL BERGEN¹, SHRUTI SINGH¹,
JOSEPH BISCHOFF², RAYMOND F. SULLIVAN³
& JAMES F. WHITE, JR.¹

Jwhite@aesop.rutgers.edu

¹*Department of Plant Biology and Pathology, Rutgers University
New Brunswick, New Jersey 08901;*

²*National Center for Biotechnology Information, National Institutes of Health
Bethesda, Maryland 20894;*

³*Center for Science & Technology, Kean University, Union, New Jersey 07083*

Abstract—*Plenodomus morganjonesii* was obtained from partially degraded leaves from New Jersey. It is described as a new species based on morphological, cultural and molecular characters that differ from other species to which it is similar. Analysis of the large subunit 28S rDNA sequences suggested that this new species is related to members of the family *Leptosphaeriaceae* in the *Pleosporales*. Separation of *Plenodomus* from *Phoma* is advocated in order to produce monophyletic genera of coelomycetes.

Key words—*Phoma*, *Pleosporales*, scleroplectenchyma, taxonomy

Introduction

The phylogenetically based classification of anamorphic forms of fungi for which no teleomorph is known has been a problem since the beginnings of systematic mycology (Fries 1828; Saccardo 1880; Grove 1935; Alexopoulos et al., 1996). The difficulty is compounded in groups of fungi such as *Phoma* Sacc. where there are limited morphological characters and they are associated with teleomorphs in different families, including *Leptosphaeriaceae*, *Melanommataceae*, *Phaeosporaceae*, and *Pleosporaceae* (Sutton 1980). The current system of classification of phomoid anamorphs places them in a single genus *Phoma* which is divided into different sections based on morphology and teleomorph connections (Boerema 1997; Boerema et al., 2004; Grondona et al., 1997; Rai 1998). This morphologically-based system is functional but requires considerable expertise to use and results in a highly polyphyletic genus *Phoma* (Bridge et al., 2003; Hawksworth 2004). The use of morphological and molecular characters to develop a phylogenetic basis for defining genera of phomoid fungi will further the establishment of monophyletic anamorph genera. Identification of phomoid fungi could be enhanced by the development of a largely DNA sequence-based system.

In a phylogenetic and developmental study of *Phoma lingam* (Tode:Fr.) Desm. and *P. wasabiae* Yokogi, Reddy, Patel, and White (1998) proposed segregation of phomoid species with teleomorphs in the *Leptosphaeriaceae* into genus *Plenodomus* Preuss. This separation was based on molecular analysis and developmental and morphological features of the pycnidia. Reddy et al., (1998) further proposed that *Phoma* should be restricted to species that grouped in the *Didymella/Phoma* clade in the *Phaeosphaeriaceae*.

In this study we studied the morphological, developmental, and cultural features of a phomoid species and evaluated its phylogenetic placement using large subunit rDNA sequences. Based on our results we have determined that this is a new species and we describe it in the genus *Plenodomus*.

Materials and Methods

Fungal Material: Isolates of *Plenodomus morganjonesii* were obtained from decaying leaves collected by J. F. White and Gerald Bills in 1998 in a swamp in Turkey Swamp Park, in Monmouth County, New Jersey. The isolation was made using the particle filtration technique (Bills et al., 2004). For this study cultures were grown on potato dextrose agar (PDA). Specimens were obtained from the American Type Culture Collection (ATCC) (Table 1) for comparison. They were revived in potato dextrose broth and subsequently plated on PDA. Cultures were maintained at approximately 23 °C in an irregular light (florescent room lighting)/dark cycle. Dried cultures of all collections were submitted to the Rutgers University Plant Pathology Herbarium (RUTPP) and representative cultures were sent to the ATCC in Manassas, Virginia.

Cultural studies: Isolates of the new species were grown on oatmeal agar (OA), malt-extract agar (MEA), and PDA, prepared as outlined by Boerema et al. (2004). In addition we grew them on czapek cellulose agar (CCA) to stimulate pycnidial production. The CCA medium contained the following: fibrous cellulose powder (Watman) 10g, sodium nitrate 2g, dipotassium phosphate 1g, magnesium sulfate 0.5g, potassium chloride 0.5g, ferrous sulfate 0.01g, bacto-agar 15g, distilled water 1 liter. All media were inoculated with 7mm plugs taken from the margins of colonies growing on CCA plates. Plates were maintained at 23 °C in an alternating light/dark cycle and examined after 5 and 7 days of growth. Descriptions represent observations after 5 days (but all of the colony diameters in the description are at 7 days). Seven-day-old colonies growing on OA, PDA, and MEA were tested for reaction with sodium hydroxide by placing one drop of 10% sodium hydroxide solution on the colony margin after Boerema et al. (2004).

Developmental and morphological studies: Developmental characters of the pycnidia were determined by sectioning blocks of CCA with pycnidia. Blocks were fixed in FAA (five parts stock formalin: five parts glacial acetic acid: 90 parts 50% ethyl alcohol) for approximately 5 days. They were then dehydrated and embedded in L. R. White® acrylic embedding medium (Polysciences, Inc., Warrington, PA) and 1µ sections were obtained using glass knives. Sections were stained on a slide warmer for 30 s in toluidine blue (0.1% aqueous) and examined with a phase contrast microscope. Conidial, pycnidial, and mycelial characters were observed in squash mounts in aniline blue (0.1% aqueous) (Figs. 2-11). Sizes are an average of at least 20 individual measurements.

Sequencing and Analyses: Amplification and sequencing of 18S small subunit (SSU) rDNA, 28S large subunit (LSU) rDNA, and internal transcribed spacer sequence 1 (ITS1) was done as previously described (Sullivan et al., 2001; White et al., 1990). In a few instances sequences were obtained directly from dried herbarium specimens (Reddy, Patel, White 1998). Voucher accession numbers are provided in Table 1.

The GCG programs Gap, Pileup and the SeqLab interface for the Wisconsin Package Version 9.1 (Genetics Computer Group, Madison, WI) were used to analyse sequences, generate alignments and make manual adjustments. PAUP version 4b10 (Swofford, 1999) was used for sequence similarity analysis of ITS1 data and for phylogenetic analysis of LSU and SSU sequences. PAUP's Base Frequency program was used to get the expected base frequency for each taxon and to do a Chi-square test for homogeneity of base frequencies across taxa. Preliminary analyses were conducted on all sequence regions (LSU, ITS and SSU) using parsimony and distance options. Because of the lack of sufficient variability in SSU rDNA sequences and its failure to separate the families *Phaeosphaeriaceae* and *Leptosphaeriaceae* (Rossman et al., 2002), the SSU region was not employed to place *P. morganjonesii* phylogenetically. In addition, ITS region was not employed in the analysis because of very high variability among the sequences included.

Maximum parsimony analyses were performed using heuristic search options with 2000 random sequence additions, tree bisection reconnection branch swapping algorithm and treating gaps as missing data. Consistency Index (CI) and Retention Index (RI) were calculated using PAUP. Jackknife analysis was performed to estimate support for the internal branches. This analysis used 1000 replicates with 37% deletion (Farris et al., 1996). The data set included 494 characters in which 90 (18%) were parsimony informative. Analysis resulted in two most parsimonious trees (Length = 197; Consistency index = 0.817; Retention index = 0.908; Fig. 12)

MODELTEST (Posada, Crandall 1998) was used to establish the model of DNA evolution that best fit the data model for the LSU data (Akaike Information Criterion) and maximum likelihood analysis with 1000 replicates was performed (using PAUP) with the resulting model. The model used was TrNef+I+G; $-lnL = 3679.6941$, $AIC = 7373.3882$; base frequencies A = 0.2492, C = 0.2148, G = 0.2928; substitution model with rate matrix R (a) [A-C] = 1.0000, R (b) [A-G] = 2.2880, R(c) [A-T] = 1.0000, R (d) [C-G] = 1.0000, R (e) [C-T] = 7.0409, R (f) [G-T] = 1.0000; Among-site rate variation (I) = 0.4267, Variable sites (G) with gamma distribution = 0.8191. MrBayes 3.0, a Bayesian phylogenetic inference program (Huelsenbeck and Ronquist, 2001), was used to determine branch support (posterior probabilities). Bayesian analysis was run with four Markov chains Monte Carlo (three cold, one heated) for 1,000,000 generations, sampling every 100 generations (including the first generation). The trees that were not asymptotic (the first 50 trees) were discarded ("burn-in"; Huelsenbeck, 2000). Bayesian analysis was done three times with a total of 29850 trees resulting. These trees were imported into PAUP and a 50% majority-rule consensus tree was produced to determine posterior probabilities. Support values are reported on the maximum likelihood tree (Fig. 12).

Table 1. Taxa used in LSU analyses

TAXA	GENBANK #	CULTURE/VOUCHER#
<i>Aureobasidium pullulans</i>	AF050239	ATCC 62921
<i>Clathrospora diplospora</i>	U43481	IMI 68086
<i>Cochliobolus ellisii</i>	AF163993	¹ —
<i>Delphinella strobiligena</i>	AY016358	CBS 735.71
<i>Didymella bryoniae</i>	AY293792/ AF046014	IMI 373225
<i>Dothidea ribesia</i>	AY016360	CBS 195.58
<i>Dothidea sambuci</i>	AF382387	CBS 198.58
<i>Lewia infectoria</i>	U43482	IMI 303186
<i>Leptosphaeria doliolum</i> 1	U43475	ATCC 32815
<i>Leptosphaeria doliolum</i> 2	U43474	ATCC 32814
<i>Phoma billsii</i>	AY293789	ATCC MYA-3680
<i>Phoma cucurbitacearum</i> (GSB10)	AY293786	ATCC MYA-3681
<i>Phoma glomerata</i> (South River)	AF126819	ATCC MYA-2373
<i>Phoma herbarum</i>	AY293791	ATCC 12569
<i>Phoma pomorum</i> (GSB12)	AY293787	ATCC MYA-3682
<i>Phoma morganjonesii</i> n.sp.	AY293785	ATCC MYA-3683
<i>Pleospora betae</i>	U43483	IMI 156653
<i>Pleospora herbarum</i> 1	U43476	ATCC 11681
<i>Pleospora herbarum</i> 2	AF382386	CBS 191.86
<i>Pyrenophora trichostoma</i>	U43477	ATCC 44111

¹— indicates that voucher accession not available

Taxonomy

Plenodomus morganjonesii was found to be distinct from previously described species (Boerema et al., 2004) based on morphological and molecular characteristics and is described as a new species.

Plenodomus morganjonesii M. S. Torres & J. F. White **sp. nov.** **Figs. 1-11**

Etym. *Plenodomus morganjonesii* is named for the mycologist Dr. Gareth Morgan-Jones

Coloniae in agaro decocto tuberorum zonatae, olivaceae-brunneae, lanosae, post 7 dies 23 °C ad 18-20 mm diam. Mycelium ex hyphis septatis, ramosis, subhyalinis, 1-3µ crassis compositum. Pycnidia solitaria, globosae vel fusiformae-cordatae, 1 ostiolata, brunnea, immersa et superficialia, pseudoparenchymatica, 30-60 X 50-80µ; paries cellularum isodiametricarum compositum. Cellulae conidiogenae hyalinae, simplices, ex cellulis interioribus parietis pycnidii, 1.5-2.5µ. Conidia enteroblastica, hyalina, simplicia, cylindrica, 1-2 X 3-5µ.

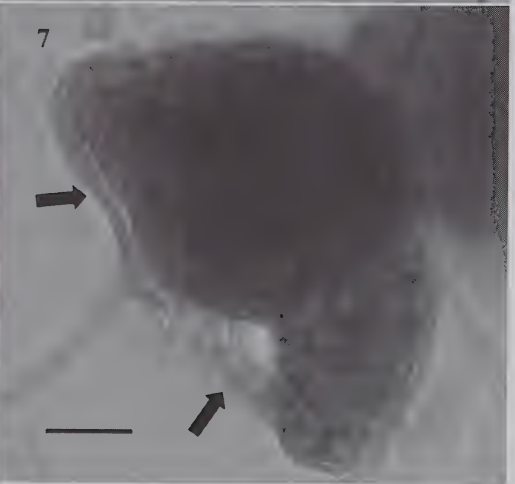
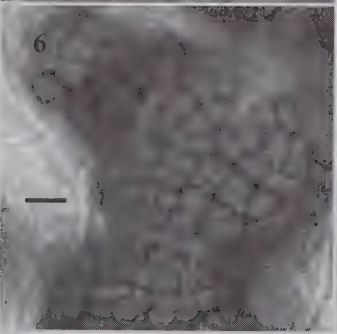
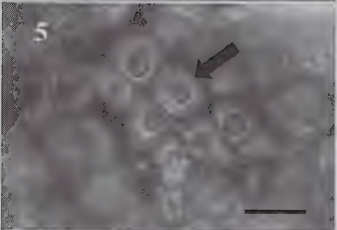
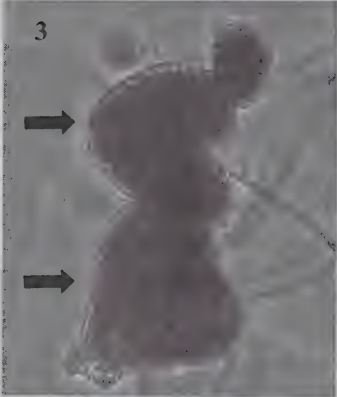
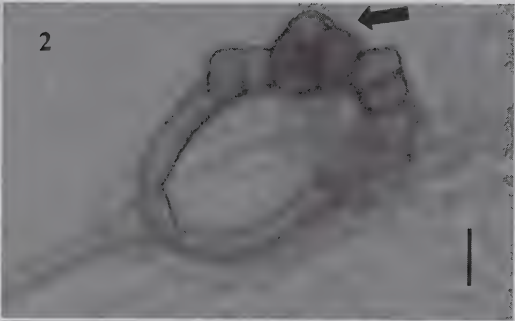
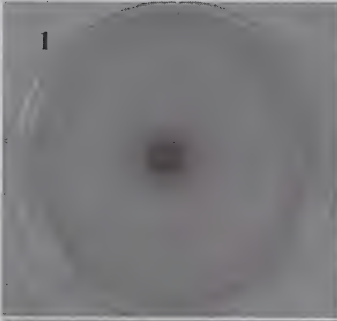
COLONIES on MEA (Fig. 1) tan-yellowish, with sparse aerial mycelium, 18-20 mm diam after 7 days at 23 °C; pycnidia (Figs. 3, 4, 7-9) solitary and in clusters of up to eight, reverse yellow, developing yellow mycelial clusters in media beneath colony. On PDA

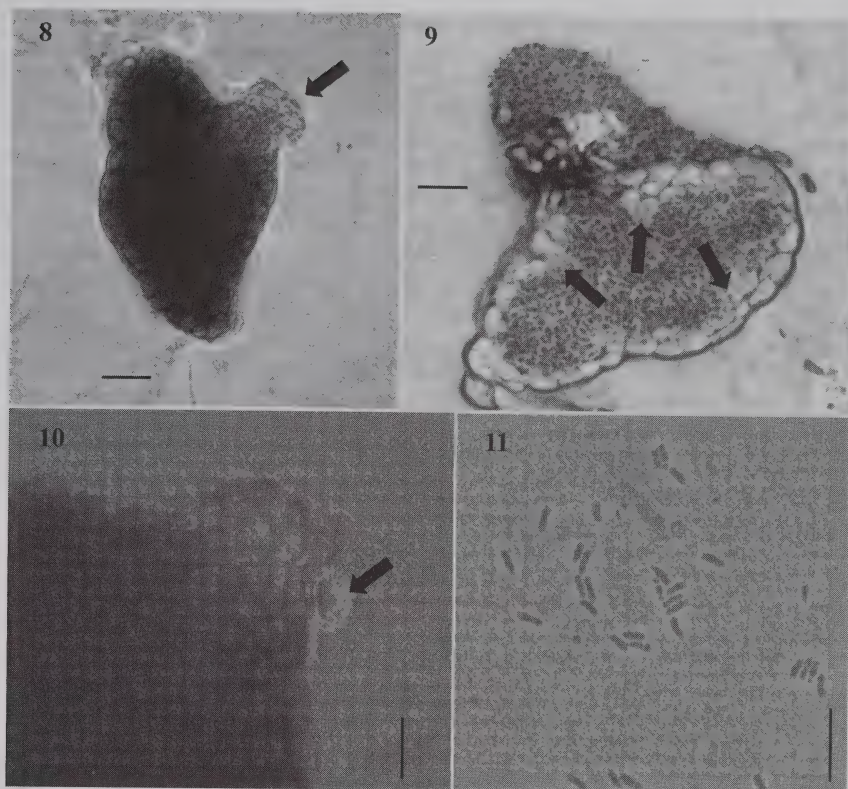
gray to light olive green with irregular lighter patches, aerial mycelium lanose, zonate with pycnidia in concentric zones, 18-20mm diam after 7 days, reverse tan centrally with black beneath pycnidial zones, with a yellow diffusible pigment in medium. On OA brown to olivaceous-gray, zonate, aerial mycelium brown to black in zones where pycnidia formed abundantly, with lanose aerial mycelium centrally, 18-20mm diam after 7 days, sectoring with abundant pycnidia in sectors and at margins but less aerial mycelium, reverse dark green-black, becoming yellowed due to diffusible pigment. Pink reaction in medium in sodium hydroxide spot test after five minutes where formerly the yellow pigment had been visible on MEA, OA, and PDA. On CCA not pigmented, with sparse mycelium and almost no aerial mycelium, 17 mm diam after 7 days, reverse not pigmented, pycnidia not fully developed. After 15 days pycnidia were immersed at various depths in medium and in concentric zones on the surface. Mycelium of septate, branched, subhyaline smooth 1-3 μm wide hyphae. Pycnidia solitary, sometimes globose, frequently arcuate-fusiform (Figs. 4, 8, 9) to cordate (Fig. 3, arrows) with two acute lateral sides bearing hyphal initial attachments (Figs. 2, 4, 7), light brown, mostly immersed, mostly pseudoparenchymatous (Fig. 6) with some scleroplectenchmous cells (Fig. 5), papillate, 30-60 wide X 50-80 μm high, with one ostiole that opens after conidia fill pycnidium (Fig. 4), ostiole neck short (Figs. 3, 4, 8-10), 10-20 μm long and 10-20 μm wide, pycnidial wall in median, vertical section composed of most 1-4 layers of ellipsoidal cells (Fig. 9) measuring 2-3 X 4-10 μm , irregularly thickened (Fig. 9) and 3-7 μm thick, wall cells in squash mounts (Figs. 5, 6) brown, isodiametric, 5-15 μm diam., sometimes with narrowed lumens (Fig. 5). Conidiogenous cells obscure, phialidic, hyaline, simple, smooth-walled, borne on the innermost cells of the pycnidial wall, doliiform, isodiametric, 1.5-2.5 μm diam. Conidia (Fig. 11) enteroblastic, hyaline, simple, eguttulate or with 2-3 large guttules, cylindrical, often slightly curved, frequently narrower on one end, smooth, aseptate, 3-5 x 1-2 μm , en masse off-white. No chlamydospores were observed on any medium although simple hyphal swellings were sometimes present in older cultures. Teleomorph not observed.

Holotype here designated: *Plenodomus morganjonesii* (RUTPP), dried culture on PDA, Turkey Swamp Park, Monmouth County, New Jersey; cultotype ATCC MYA-3683.

Discussion

Plenodomus morganjonesii is similar to the cosmopolitan saprophytic species *Phoma fimeti* Brunaud in colony characteristics (Boerema et al., 2004; Sutton, 1980). It may be readily distinguished from *P. fimeti* because the latter does not show a color change in the sodium hydroxide spot test and the conidia are ellipsoidal rather than cylindrical as in *P. morganjonesii*. Additionally, pycnidia of *P. fimeti* are frequently globose and the pycnidial walls in median vertical section are more regular in thickness and are composed of cells that are isodiametric and squared rather than ellipsoidal (White, 1983). *Phoma fimeti* is known to bear affinity to teleomorphic genus *Didymella* Sacc. and its pycnidial development and structure are consistent with species grouped therein (Boerema et al., 2004).





Plenodomus morganjonesii. Figs. 1-11. Morphological and cultural features.

(Figs. 1-7, **left**). 1. Culture on MEA medium after 7 days. 2. Symphogenous pycnidial primordium (arrow) showing typical ring form of initial with primordial pycnidium developing from fusion of hyphae (suspensors) arising from a common hyphal strand (bar = 5µm). 3. Cordate pycnidia (arrows; bar = 50µm). 4. Solitary pycnidium showing irregular fusiform shape and globose mass of conidia (arrow) emerging from lateral ostiole (bar = 50µm). 5. Developing pycnidial wall (surface view) showing narrowed lumens (arrow) in sclerenchyma cells (bar = 5µm). 6. Pycnidial wall with pseudoparenchyma cells (bar = 5µm). 7. Pycnidium showing two lateral suspensors (arrows; bar = 10µm).

(Figs. 8-11, **above**). 8. Pycnidium showing papillate ostiole (arrow; bar = 10µm). 9. Vertical section of pycnidium showing wall with irregularly thickened areas (arrows) and sclerified cells around apical ostiolar region (bar = 10µm). 10. Surface view of ostiolar papilla showing sloughed sclerenchyma cell (arrow; bar = 10µm). 11. Conidia stained with aniline blue (bar = 10µm).

The genus *Plenodomus* is typified by *Plenodomus lingam* (Tode : Fr.) Höhn (teleomorph: *Leptosphaeria maculans* (Desm.) Ces. & De Not.). Boerema (1982) placed *Plenodomus* as a section of the genus *Phoma* and Boerema et al. (2004) include in that section approximately 30 species with validly published binomials in *Plenodomus*.

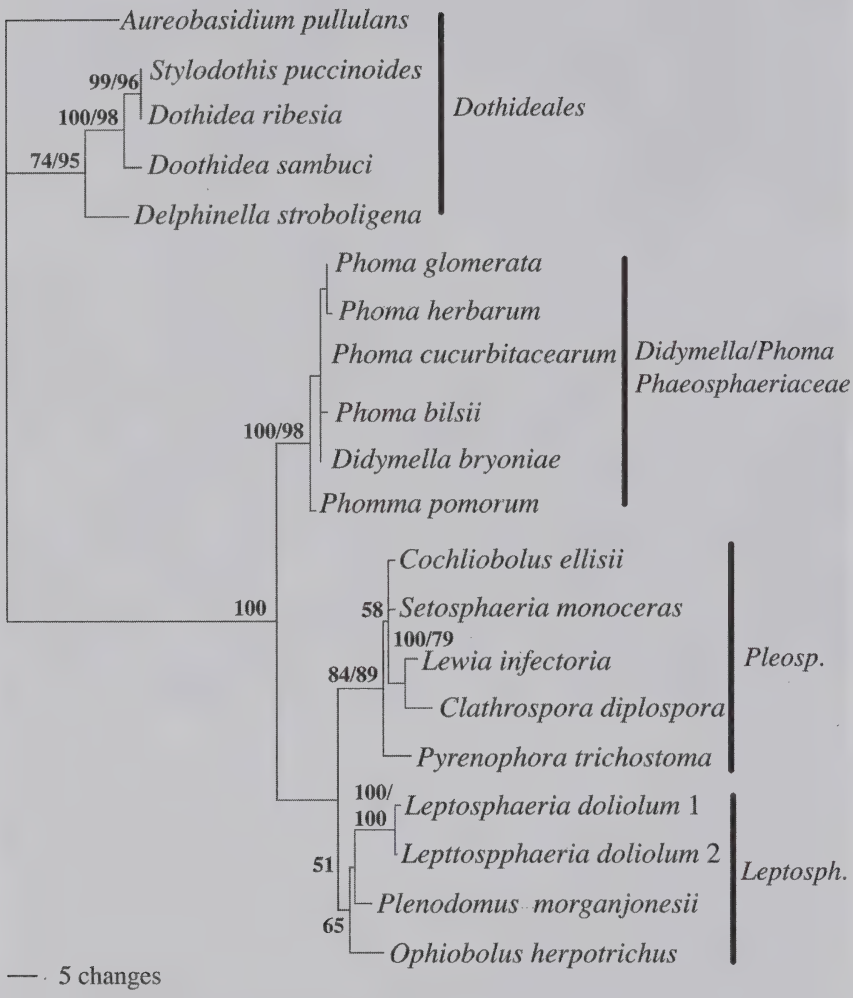


Fig. 12. Tree resulting from parsimony analysis of LSU region (tree length = 197) with Jackknifing support and Bayesian branch support values mapped onto tree. The Dothideales were defined as outgroup. Families are indicated on the tree to the right of species, Pleosp. = *Pleosporaceae*, Leptosph. = *Leptosphaeriaceae*. This analysis illustrates placement of *Plenodomus morganjonesii* in a *Leptosphaeriaceae* clade.

Most species in *Plenodomus* produce pycnidia composed of at least some scleroplectychmatous cells in which the inner cell wall is irregularly thickened. Additionally the walls in the interior of the pycnidia bear irregular files of cells that extend into the pycnidial cavity (Reddy, Patel, White, 1998). Generally the ostiole in pycnidia of species of *Plenodomus* does not develop until the pycnidium is fully developed (Boerema et al, 2004; Reddy et al. 1998). Most species referred to *Plenodomus* (Boerema et al., 2004) have known teleomorphs in genus *Leptosphaeria* Ces. & De Not. In contrast, the genus *Phoma*, as typified by *Phoma herbarum* Westend., is characterized by species which produce pycnidia with minimally sclerifeid walls, evenly thickened inner wall layers, and teleomorphs in *Didymella* (Morgan-Jones 1988a,b; Morgan-Jones, White, 1983; White, Morgan-Jones, 1986).

Although no teleomorph was observed for *P. morganjonesii*, it grouped in the *Leptosphaeriaceae* clade (51% Jackknife support) along with *L. doliolum* (Pers.:Fr.) Ces. & De Not. (anamorph = *Plenodomus doliolum* (Höhn.) Höhn.) and *Ophiobolus herpotrichus*. In culture the fungus has some features that are consistent with *Plenodomus*. The mode of pycnidial formation is symphogenous with pycnidial formation being initiated by the fusion of two separate hyphal strands often arising from the same hypha (Fig. 2). This leads to the characteristic arcuated-fusiform to cordate appearance of many of the mature pycnidia (Figs. 3, 4, 7-9). Frequently the original hyphal initials are visible attached to the lateral ends of the arcuate to cordate pycnidia (Figs. 4, 7). The symphogenous method of pycnidial development is often found in species referred to *Plenodomus* (Boerema et al., 2004). The early pycnidial wall is unevenly thickened on the inner surface (Fig. 9) as is evident in many species of *Plenodomus* (Boerema et al., 2004). As the pycnidium develops, the outer surface layer, especially near the ostiolar pore, becomes sclerifeid with narrowed lumens (Fig. 5). Sclerenchyma is another feature of many species in *Plenodomus* (Boerema et al., 2004). The ostiolar pore does not appear to develop until later in pycnidial formation although the entire development process is only a few days in duration. The cells forming the ostiole are highly sclerified (appearing refractive under phase-contrast) and are sloughed off to reveal the ostiolar pores (Figs. 8-10). Typically in *Plenodomus* ostiolar pores do not form in the pycnidial primordium but develop late in maturation (Boerema et al., 2004). The thin-walled pseudoparenchymatous pycnidia of *P. morganjonesii* are consistent with the thin-walled type-I pycnidia of some species of *Plenodomus* but no thick-walled plectosclerenchymatous type-II pycnidia have been observed in our cultures. It is possible that type-II pycnidia are produced on natural substrates. Separation of monophyletic units of phomoid fungi into distinct genera will improve the precision of our system of classifying phomoid fungi. Along these lines more extensive phylogenetic studies must be conducted with a broad spectrum of phomoid fungi in distinct families of the *Pleosporales*. It is likely that phylogenetic work in phomoid fungi would result in a system of classification and tools for identification that are more accessible to a broad spectrum of mycologists.

Acknowledgements

This research was supported in part by the New Jersey Agricultural Experiment Station. We are grateful to Drs. Mary E. Palm and Mahendra Rai for reviewing versions of this manuscript.

References

- Alexopoulos CJ, Mims CW, Blackwell M. 1996. Introductory Mycology. John Wiley & Sons, New York, NY.
- Bills GF, Christensen M, Powell M, Thorn G. 2004. Saprobiic Soil Fungi. Pages 271-302 in: Biodiversity of Fungi: Inventory and Monitoring Methods (eds Mueller G, Bills GF, Foster M). Elsevier Academic Press, New York.
- Boerema GH. 1970. Additional notes on *Phoma herbarum*. Persoonia 6: 15-48.
- Boerema GH. 1982. Mycologisch-taxonomisch onderzoek. *Phoma*-soorten van de sectie *Plenodomus*. Verslagen en Mededelingen Plantenziekten Kundige Dienst Wageningen 158: 28-30.
- Boerema GH. 1997. Contributions towards a monograph of *Phoma* (coelomycetes)-V. Subdivision of the genus in sections. Mycotaxon 64: 321-333.
- Boerema GH, De Gruyter J, Noordeloos ME, Hamers MEC. 2004. *Phoma* Identification Manual: Differentiation of Specific and Infra-Specific Taxa in Culture. CABI, The Netherlands.
- Bridge PD, Roberts PJ, Spooner BM, Panchal G. 2003. On the unreliability of published DNA sequences. New Phytologist 160: 43-48.
- Farris JS, Albert, VA, Källersjö M, Lipscomb D, Kluge AG. 1996 Parsimony jackknifing outperforms neighbor-joining. Cladistics 12: 99-124.
- Fries EM. 1828. Elenchus Fungorum 2. Gryphiswaldiae. Reprinted in 1952 by Johnson's Reprint Corporation, New York.
- Grondona I, Monte E, Garcia-Acha I, Sutton BC. 1997. *Pyrenochaeta dolichi*: an example of a confusing species. Mycol. Res. 101: 1405-1408.
- Grove WB. 1935. British Stem and Leaf Fungi. 1: 1-448.
- Hawksworth DL. 2004. 'Misidentifications' in fungal DNA sequence databanks. New Phytologist 161: 13-14.
- Huelsenbeck JP. 2000. MrBayes: Bayesian inference of phylogeny. Distributed by the author. Department of Biology, University of Rochester, USA.
- Huelsenbeck JP, Ronquist F. 2001. MrBayes: Bayesian inference of phylogenetic trees. Bioinformatics 17: 754-755.
- Morgan-Jones G. 1988a. Studies in the genus *Phoma*. XIV. Concerning *Phoma herbarum*, the type species, a widespread saprophyte. Mycotaxon 33: 81-90.
- Morgan-Jones G. 1988b. Studies in the genus *Phoma*. XV. Concerning *Phoma multirostrata*, a leafspot-inducing and soil-borne species in warm climates. Mycotaxon 33: 339-351.
- Morgan-Jones G, White JF Jr. 1983. Studies in the genus *Phoma*. I. *Phoma americana* sp. nov. Mycotaxon 16: 403-413.
- Posada D, Crandall KA. 1988. Modeltest: testing the model of DNA substitution. Bioinformatics 14: 817-818.
- Rai MK. 1998. The Genus *Phoma* (Identity and Taxonomy). International Book Distributors, Dehra Dun, India.
- Reddy PV, Patel R, White JF Jr. 1998. Phylogenetic and developmental evidence supporting reclassification of cruciferous pathogens *Phoma lingam* and *P. wasabiae* in genus *Plenodomus*. Canad. J. Bot. 76: 1916-1922.
- Rossmann AY, Farr DF, Castlebury LA, Shoemaker R, Mengistu A. 2002. *Setomelanomma holmii* (Pleiosporales, Phaeosphaeriaceae) on living spruce twigs in Europe and North America. Can. J. Bot. 80: 1209-1215.

- Sullivan R, Bergen MS, Patel R, Bills GF, Alderman SC, Spatafora J, White JF Jr. 2001. Features and phylogenetic status of an enigmatic clavicipitalean fungus *Neoclaviceps monostipa* gen. et sp. nov. *Mycologia* 93: 90-99.
- Saccardo PA. 1880. Conspectus generum fungorum italiae inferiorum nempe ad Sphaeropsideas, Melanconieas et Hyphomyceteas pertinentium, systemate sporologico dispositoru. *Michelia* 2: 1-38.
- Sutton BC. 1980. The Coelomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
- Wehmeyer LE. 1961. A World Monograph of Genus *Pleospora* and Its Segregates. University of Michigan Press. Ann Arbor.
- Swofford DL. 1999. PAUP. Phylogenetic Analysis Using Parsimony (and Other Methods), Version 8. Sinauer Associates, Sunderland, Massachusetts.
- White JF Jr. 1983. Taxonomic and Biological Studies in the Coelomycetes (Thesis). Auburn University, Alabama.
- White JF Jr, Morgan-Jones G. 1986. Studies in the genus *Phoma*. V. Concerning *Phoma pomorum*. *Mycotaxon* 25: 461-466.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pages 315-322, in: PCR protocols: a guide to methods and applications. (eds Innis MA, Gelfand DH, Sninsky JJ, White TJ), Academic Press, Inc., San Diego, CA.

**NATS truffle and truffle-like fungi 12:
Rhizopogon ater sp. nov. and *R. brunsii* sp. nov.
(*Rhizopogonaceae*, Basidiomycota)**

LISA C. GRUBISHA

lgrubisha@iab.alaska.edu

*Institute of Arctic Biology, University of Alaska Fairbanks
Fairbanks, Alaska 99775-7000*

JAMES M. TRAPPE

trappej@onid.orst.edu

*Department of Forest Science, Oregon State University
Corvallis, Oregon 97331-7501*

ADRIAN R. BEYERLE & DAN WHEELER

*North American Truffling Society Box 296
Corvallis, Oregon 97339-0396*

Abstract—Two new species of *Rhizopogon* are described as *R. ater* from western Oregon and southwestern Washington and *R. brunsii* from southern California. *R. ater* is placed in *Rhizopogon* subgenus *Villosuli* and associates with *Pseudotsuga menziesii*, whereas *R. brunsii* belongs to *Rhizopogon* subgenus *Amylopogon* and associates with two- to five-needle pines in southern California.

Key words—hypogeous, *Boletales*, ectomycorrhizal fungi, taxonomy

Introduction

Rhizopogon is a hypogeous, ectomycorrhizal genus that associates with members of the *Pinaceae*. It reaches its greatest abundance and diversity in western North America (Smith and Zeller 1966, Molina et al. 1999). Many habitats of that region have not been explored for hypogeous fungi, so discovery of undescribed species is not surprising. Here we describe two new species associated with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and pines (*Pinus muricata* D. Don, *P. radiata* D. Don and *P. torreyana* Carrière), respectively.

Methods and materials

Notes were recorded on characters of fresh specimens that were then dried on a food dehydrator with forced air at 35 °C (95 °F). Colors are in general terms. Microscopic characters were determined from hand sections mounted in 5% KOH or Melzer's reagent as indicated.

Placement of *R. ater* within *R.* subgenus *Villosuli* and *R. brunsi* within *R.* subgenus *Amylopogon* was tested through phylogenetic analysis of DNA sequences. Grubisha et al. (2002) previously confirmed that *R. ater* is part of *R.* subgenus *Villosuli*. Genomic DNA was extracted from small pieces of *R. brunsi* basidiocarps following Kjølner and Bruns (2003). Polymerase chain reaction (PCR) conditions for amplification of the nuclear ribosomal internal transcribed spacer region (ITS) were previously described (Gardes and Bruns 1993). Sequencing of both strands was performed using a BigDye Terminator Cycle Sequencing Ready Reaction Kit (Applied Biosystems Co.) and an ABI PRISM 3100 Genetic Analyzer. Sequences were edited using Sequencher 4.2.2 (Gene Codes Corp.) and have been deposited in GenBank as accession numbers AY971813–AY971841. Sequence alignment and phylogenetic analyses using maximum parsimony as the optimality criterion followed Grubisha et al. (2002). Sequences from holotype and paratype collections of species in *R.* subgenus *Amylopogon* were obtained from GenBank (Bidartondo and Bruns 2002, Grubisha et al. 2002). ITS sequences from two species in *R.* subgenus *Roseoli*, *R. vulgaris* (Vittad.) M. Lange (GenBank no. AF062934) and *R. roseolus* (Corda) Th. Fr. (AF058315), were used as the outgroup.

Phylogenetic results

Analysis of ITS sequences of *R. ater* and other *Rhizopogon* species placed it in *Rhizopogon* subgenus *Villosuli* in close relationship to *R. vinicolor* A. H. Sm. (Grubisha et al. 2002, as “*R. sp. nov.* JMT 17466”, GenBank accession no. AF071438; Kretzer et al. 2003).

Sequences of *R. brunsi* formed a strongly supported monophyletic clade within *R.* subgenus *Amylopogon* and a sister-group to the *R. arctostaphyli* A. H. Sm. clade (Fig. 1). An alignment of 634 nucleotide characters from 28 ITS sequences from *R. brunsi* collections and 20 sequences from *Rhizopogon* species in *R.* subgenus *Amylopogon* plus the two outgroup sequences contained 72 parsimony informative characters. Phylogenetic analyses resulted in 216 equally parsimonious trees, each of 167 steps, CI=0.886, RI=0.964. Bootstrap values strongly supported the *R. brunsi* clade as distinct from the *R. arctostaphyli* clade.

Taxonomic description

***Rhizopogon ater* Trappe & Grubisha sp. nov.**

Fig. 2 a–c

Basidiomata 7–20 x 9–32 mm. *Peridium* juventute sordide album vel griseum sub suprapelle tenui hypharum brunnearum, ubi contusa saepe erubescens, vinascens vel brunnescens, maturitate rubroatrum, violaceoatrum vel olivaceoatrum. *Rhizomorphae* basi singulatae vel fasciculatae. *Gleba* juventute grisea vel sordide olivacea, mox olivaceoater, cyanater vel viridiater. *Hymenium* et *peridium* in aqua vel solutione Melzeri granulis atris abundis quibus in KOH in pigmento viridi dissolvescens. *Basidia* 13–23 x 7.5–10 µm. *Subhymenium* cellulis isodiametris 7–10 µm latis. *Fibulae* absentes. *Sporae* obtusae vel ellipsoideae, laeves, 6–7 (–10) x (2.5–) 3–3.5 (–4), hyalinae, nonamyloideae, interdum in aqua vel solutione Melzeri granulis atris adhaerentibus. *Holotypus* hic designatus: Trappe 17466, leg. D. Wheeler in OSC.

Etymology — Latin, *ater*, (black) in reference to the black or near black colors of peridium and gleba of mature specimens.

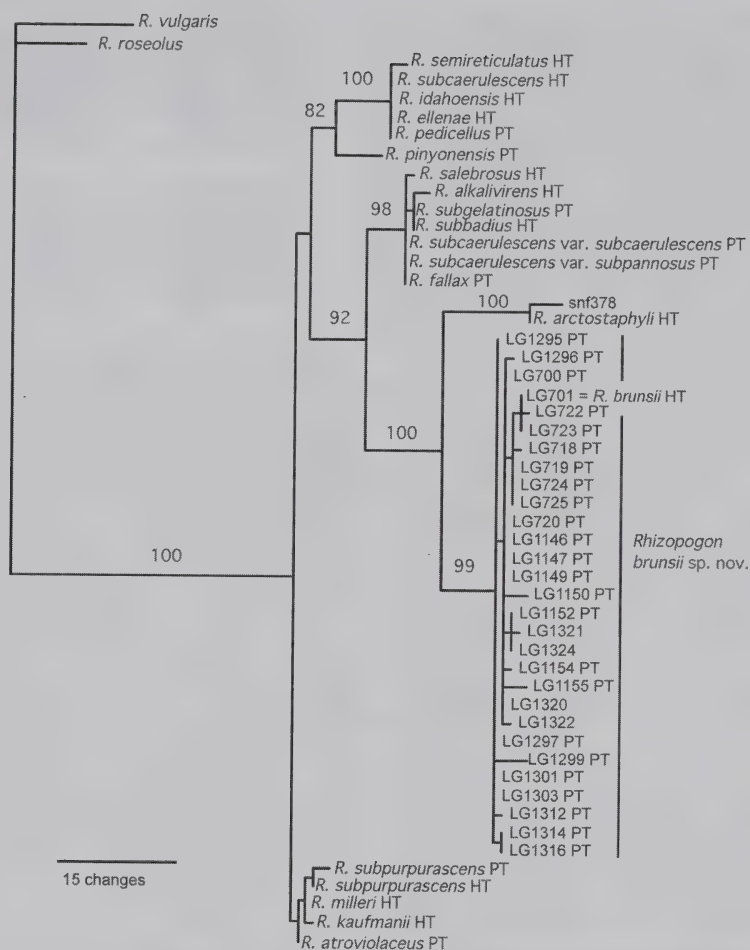


Fig. 1. One of 216 equally parsimonious trees of 167 steps resulting from an alignment of 634 nucleotide characters from ITS sequences from *R. brunsii* collections and species in *R.* subgenus *Amylopogon*. Sequence alignment contained 72 parsimony informative characters. CI=0.886, RI=0.964; Bootstrap values greater than 70 are shown. HT=Holotype collection; PT=Paratype collection. *R. vulgaris* and *R. roseolus* were chosen as the outgroup.

Basidiomata 7–20 x 9–32 mm broad, globose to subglobose, in youth sordid white to gray under a thin suprapellis of brown hyphae, often staining pink to vinaceous or brown where cut or bruised, by maturity becoming reddish black to violaceous black or olivaceous black over all, drying dull black to brownish black or blackish olive but often with vinaceous areas, the inner peridium sometimes pink. **Rhizomorphs** appressed at and emanating from the base singly or in clusters of a few, up to 2 mm thick at place of attachment, dark brown and much branched, often breaking off when the specimen

is unearthed. **Gleba** in youth gray to dirty olive, soon becoming olive black to bluish black or greenish black, when moist and cut open often with a metallic luster, drying dark olive to olive black; columellae rare, when present percurrent or inserted into the gleba only a few mm, sordid yellow when fresh, staining pink, drying pink. **Chemical reactions:** KOH on fresh, white peridium immediately olive, soon black, on fresh or dry gleba instantly black. **Odor** not distinctive or sometimes sweet or onion-like.

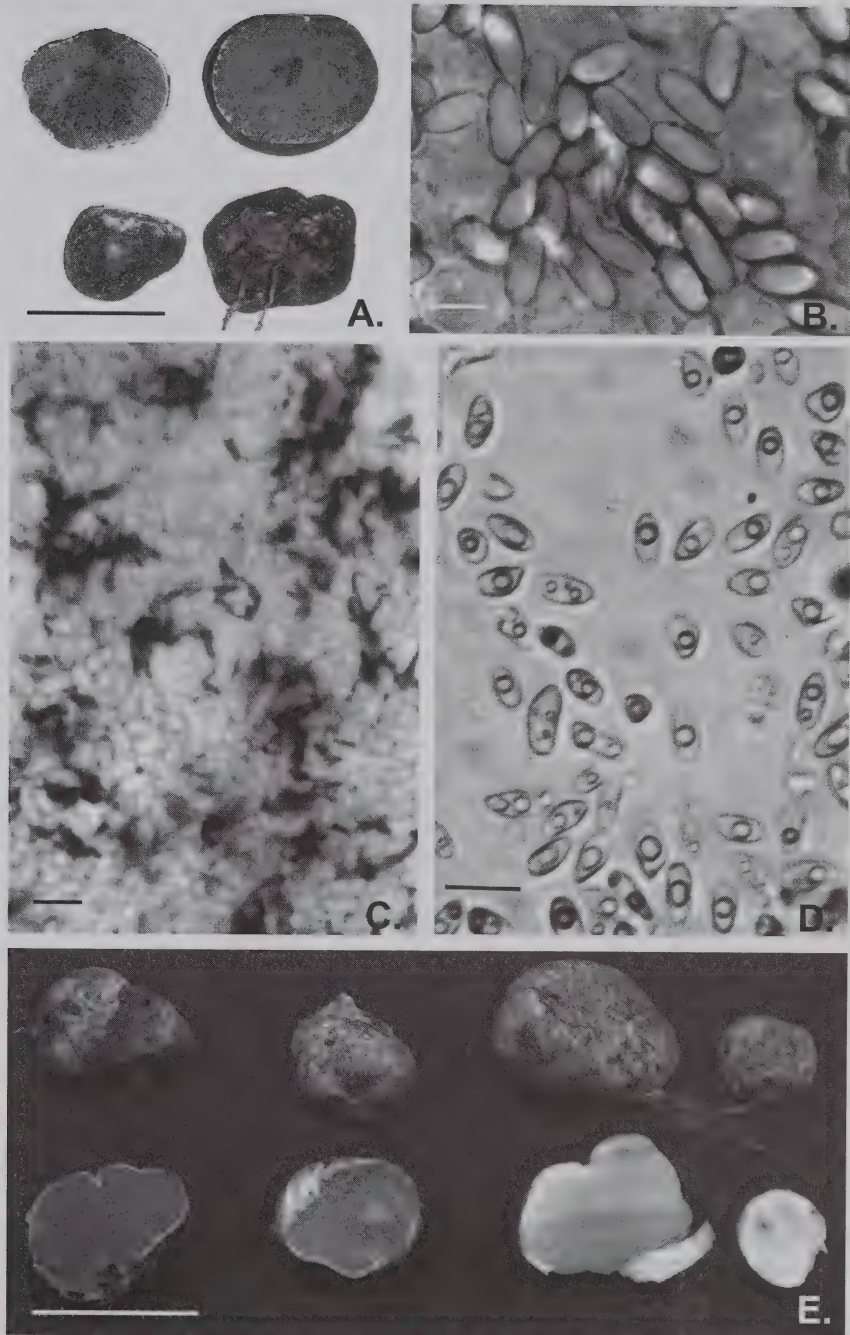
Black granules present in water or Melzer's reagent, scattered in the peridium and glebal trama but profuse in the subhymenium and hymenium, in KOH dissolving into a green pigment. **Peridium** 270-440 μm thick; suprapellis of scattered to thinly layered hyphae 3-6 μm broad and with thin to thick brown walls; pellis of hyaline hyphae 1-6 μm broad, obscured by massive deposits of amorphous, yellowish brown pigment that form brown pigment balls in Melzer's reagent; subpellis of hyphae similar to those of the pellis, in KOH with a diffuse pink to red color. **Glebal trama** of interwoven, gelatinized hyphae 2-5 μm broad. **Hymenium** with abundant, KOH-soluble, black granules as in the peridium. **Basidia** clavate to clavate-cylindrical, 13-23 x 7.5-10 μm , by maturity with gelatinous-thickened walls. **Subhymenium** of isodiametric cells 7-10 μm broad, by maturity with gelatinous-thickened walls. **Clamp connections** absent.

Spores obtuse to ellipsoid, smooth, 6.0-7.0 (-10.0) x (2.5-) 3-3.5 (-4) μm , in youth with 1-2 guttules and often appearing false septate, hyaline to brown in mass in KOH, nonamyloid, in Melzer's reagent brown in mass, sometimes in water or Melzer's reagent with black granules adherent to the surface.

Habit, habitat, mycorrhizal hosts, distribution and season — Solitary to gregarious in natural forests or plantations of *Pseudotsuga menziesii* in pure or mixed stands from near sea level to ca 600 m elevation in the northern Oregon Coast Ranges and rarely in the southern Washington Cascades. October through December.

Collections examined: HOLOTYPE here designated: **Oregon, Polk Co.** — Black Rock (Lackiamute Tree Farm), T85N, R7W, Rd. 1300 out of Falls City, col. Dan Wheeler, Trappe 17466, 4 Nov. 1995 (OSC 80942; isotypes BPI, UC). PARATYPES: **Oregon:** *Benton Co.* — near Blodgett, Starker Forests Tree Farm, col. B. Winn, Trappe 7703, 28 Oct. 1983 (OSC 80937) and L. Schramm, Trappe 30517, 6 Nov. 2004 (OSC 111363). *Lincoln Co.* — 3.2 km E of Cape Perpetua, col. A. B. Walters, Trappe 5624A, 18 Nov. 1979 (OSC 80936, UC). *Polk Co.* — Black Rock Rd., Luckiamute Tree Farm, 4-4.5 miles from Falls City, Col. W. Bushnell, Trappe 8934, 6 Sept. 1986 (OSC 80938), R. & N. Nett, Trappe 13351, 5 Nov. 1994 (OSC 111292), Z. Carter, Trappe 13353, 5 Nov. 1994 (OSC 80939, BPI, FH, K, NY, UC), A. Beyerle, Trappe 17419, 7 Oct. 1995 (OSC 80940, CANB), L. Schramm, Trappe 17428, 7 Oct. 1995 (BPI), A. Beyerle, Trappe 17423, 13 Oct. 1995 (NY), A. Beyerle, Trappe 17436, 27 Oct. 1995 (OSC 80941), A. Beyerle, Trappe 17488, 9 Nov. 1995 (FH, UC), A. Beyerle, Trappe 25879, 14 Nov. 2000 (OSC 80945), A. Beyerle, Trappe 17623, 20 Dec. 1995 (OSC 80943), A. Beyerle, Trappe 22797, 11 Dec. 1997 (OSC 111294), A. Beyerle, Trappe 25853, 26 Dec. 2000 (OSC 80944) and Trappe 25855 (BPI, K, UC), A. Beyerle, Trappe 27157, 21 Nov.

Fig. 2. Basidiomes and light microscopy of *Rhizopogon ater* and *R. brunsii*. A. *R. ater* showing dark gleba and rhizomorphs. B. *R. ater* basidiospores. C. Black granules that are abundant in the subhymenium and hymenium. D. *R. brunsii* basidiospores. E. *R. brunsii* showing rhizomorphs and different colors of the gleba. Scale bars: A = 2.5 cm; B, C, D = 10 μm ; E = 4 cm.



2001 (OSC 80946), A. Beyerle, Trappe 28265, 25 Nov. 2002 (OSC 111295). *Tillamook Co.*—Cedar Cr., T2N, R7W, Sec 30, SW 1/4, M. Layes, Trappe 22770 17 June 1996 (OSC 111293). *Yamhill Co.*—Siuslaw National Forest, Hebo Ranger District, Agency Creek, T4S, R8W, Sec 32, S. McDowell, Trappe 28031, 5 Oct. 2000 (OSC 80934). **Washington, Skamania Co.**—Gifford Pinchot National Forest, Panther Creek, ca 0.5 mi N of Eight-mile Cr., Perkins, Trappe 27184, 14 Nov. 2000 (OSC 80935).

Comments — The black peridium and gleba of both fresh and dry, mature specimens of *R. ater* are distinctive for the genus. This color comes from the black granules that are deposited throughout the basidiomata, most profusely in the subhymenium and hymenium of mature specimens. The effect of microscope mounts in KOH, with the gleba flushed green from dissolved granules and the peridial subpellis red, is startling and pleasing to the eye. Such granules are common in several other species of *R. subgen. Villosuli*, e.g. *R. villosulus* Zeller, but usually only in the peridium and sometimes the immediately adjacent gleba. In no other species do the granules occur in such profusion throughout the gleba as in *R. ater*. These granules do not occur in *R. vinicolor*, the species with the closest molecular relationship to *R. ater* of those studied by Grubisha et al. (2002).

The granule deposits occur only in members of subgen. *Villosuli*, so they appear to be phylogenetically meaningful at the subgenus level but not among sections within the *Villosuli*. Alexander H. Smith was the first to discover these granules in members of *R. subgen. Villosuli* and originally regarded them as amyloid, because he saw them in mounts in Melzer's reagent but not KOH (Smith and Zeller 1966). Later, at the suggestion of Dr. Robert Shaffer, Smith made water mounts of members of the *Villosuli* and discovered that the granules can be seen in water mounts and hence are not amyloid (Smith & Harrison 1968).

The relationship between *R. ater*, with its abundant granules, and *R. vinicolor*, which lacks granules, was unexpected on morphological grounds. However, other characters relate them morphologically, especially the strong pink staining of the peridial subpellis when bruised or mounted in KOH, and the very scanty suprapellis of brown-walled hyphae compared to the well developed suprapellis of other species in the *Villosuli*. We do not know if *R. ater* forms the tuberculate mycorrhizae similar to those of Douglas-fir + *R. vinicolor* and related species (Trappe 1965, Zak 1971, Molina et al. 1999).

***Rhizopogon brunsi* Grubisha & Trappe, sp. nov.**

Fig. 2 d–e

Basidiomata 7–45 mm lata, subglobosa, ellipsoidea vel irregularia. *Peridium* filis intertextis, juventute album areis luteis, avellaneis vel auranteobrunneis, maturitate pallide vinaceum vel sordidum, 0.3–2.5 mm crassa. *Rhizomorphae* basi fasciculatae et ubique appressae, albae vel sordidae, maturitate interdum subnigrae. *Gleba* firma, juventute alba, maturitate olivaceobrunnea vel fusco-olivacea. *Basidia* 8.5–11.5 (–19) x (3–) 4.5–6 µm. *Subhymenium* cellulis isodiametris. *Fibulae* absentes. *Sporae* obtusae vel ellipsoideae, laeves, 7–9.5 (–12) x (3–) 4–6 (–7) µm, hyalinae, nonamyloideae. *Holotypus* hic designatus: LCG 701, leg. J.M. Trappe in UC, isotypus in OSC.

Etymology — In honor of Dr. Thomas D. Bruns, who has made important contributions to our understanding of the life history and ecology of *Rhizopogon* in California pine forests, to the field of mycorrhizal ecology, and for collecting some of the collections cited below.

Basidiomata 7-45 mm broad, subglobose to ellipsoid or irregular, white in youth, developing yellow to yellow-brown or orange-brown streaks and patches where pressed against needles or sticks, at maturity pale gray to pale vinaceous or dingy, in cross-section white, unchanging where cut or bruised, the surface netted by minute, interwoven strands, 0.3 – 2.5 mm thick and varying that much on a single specimen, thickest at the basidiome base, drying brown. **Rhizomorphs** loosely clustered at base and appressed overall, white to dingy, the larger ones darkening to almost black with age. **Gleba** firm, white in youth, at maturity yellowish-olive to olive and finally olive-brown to dark grayish olive, exuding moisture when cut, the locules 3-5 per mm² and spore-filled at maturity; columella lacking, except in one specimen with two columns 2-3 mm wide of white sterile tissue intruding to the center. **Chemical reactions:** KOH on fresh white peridium instantly pink, occasionally with a blue fringe at the edge of the drop, soon blue overall and finally blue black to olive black; on brown peridium instantly dark brown and soon brownish black; on white peridial cross-sections quickly pink to blue, then black; on brown cross-sections instantly dark brown, quickly brownish black. Melzer's reagent non-reactive on fresh white gleba, purplish gray on light olive gleba, dark purplish gray on dark olive gleba. No obvious reaction on dried gleba from KOH or Melzer's reagent. **Odor** not distinctive.

Peridium of appressed, interwoven hyphal strands, the hyphae hyaline, thin-walled, 3.9-10.8 μ m broad, in KOH with abundant, pink to gray or faintly olive extracellular pigment deposits, in Melzer's reagent with orange-brown pigment balls. **Glebal trama** with a narrow center of subparallel hyphae 4.6-6.2 μ m broad surrounded by interwoven gelatinized hyphae, often with extracellular purple to black particles in water, KOH and Melzer's reagent. **Basidia** thin-walled, clavate to cylindrical, 8.5-11.5 (-19) x (3-) 4.5-6 μ m. **Clamp connections** absent.

Spores 7-9.5 (-12) x (3-) 4-6 (-7) μ m, ellipsoid to broadly ellipsoid, often irregular to reniform, subtriangular, smooth, in youth with 1-2 guttules, in KOH hyaline singly, brownish yellow in mass, in Melzer's reagent hyaline to faintly amyloid in youth, at maturity pale yellow singly to brownish yellow in mass.

Habit, habitat, mycorrhizal hosts, distribution and season — Gregarious to caespitose mostly 1-3 cm deep in mineral soil in natural forests or under individually planted trees of *Pinus muricata*, *P. radiata*, and *P. torreyana* in pure or mixed stands in southern California (Santa Barbara, San Diego, and San Luis Obispo Counties); January and February.

Collections examined: HOLOTYPE here designated: **California:** *Santa Barbara Co.*—along Harris Grade Rd, north of Lompoc 34° 44.06N, 120° 26.44W, col. J. M. Trappe, LCG 701, 11 Jan. 2002 in UC, isotype in OSC. PARATYPES — **California:** *San Diego Co.*—Torrey Pines State Reserve, 32° 54 N, 117° 14 W, along North Torrey Pines Road, col. L. C. Grubisha, LCG 1312-1316, 21 Jan 2003(UC); Torrey Pines State Reserve Extension, 32° 56 N, 117° 14 W, along Red Ridge trail, col. L. C. Grubisha LCG 1295-1303, 21 Jan 2003 (UC). *San Luis Obispo Co.*—University of California Kenneth B. Norris Rancho Marino Natural Reserve, 35° 32 N, 121° 05 W, col. L. C. Grubisha, LCG 1146, 1147, 1149, 1150, 1152, 1154, 1155, 5 Feb. 2002 (UC). *Santa Barbara Co.*—along Harris Grade Rd, N of Lompoc 34° 44.06N, 120° 26.44W, col. T. D. Bruns and L. C. Grubisha, LCG 720, 11 Jan 2002 (UC). Rucker Rd. N of Lompoc

near Mission La Purisma, 34° 44 N, 120° 26 W, col. T. D. Bruns, LCG 718, 722, 725, 11 Jan 2002 (UC), col. L. C. Grubisha, LCG 700, 723, 11 Jan 2002 (UC), col. J. M. Trappe, LCG 719, 724, 11 Jan 2002 (UC, OSC). All specimens deposited in UC and isotypes in OSC.

Comments — DNA sequence data (Fig. 1) indicate *Rhizopogon brunsii* is most closely related to *R. arctostaphyli*, but these species are not similar morphologically. Spores of *R. brunsii* are larger and wider, nonamyloid, and the fresh peridium does not bruise red. *Rhizopogon arctostaphyli* is best characterized by yellow tones overlaid by gray in the peridium and amyloid spores in mature specimens (Smith and Zeller 1966). These characters are absent in *R. brunsii*. *R. brunsii* has the broadest spores in *R.* subgenus *Amylopogon*, up to 7 μm ; *R. kauffmanii* A. H. Sm. and Zeller has the next broadest spores (up to 5 μm) but is not closely related to *R. brunsii* (Fig. 1). The taxonomy and phylogeny of species of *R.* subgenus *Amylopogon*, to which these species belong, is beset with difficulties that remain to be resolved. The morphological characters originally used to differentiate its species are often inadequate for that purpose (Bidartondo and Bruns 2002), so the entire subgenus needs reworking with the help of molecular tools.

Kjøller and Bruns (2003) initially detected what we describe here as *R. brunsii* from spore bank bioassays. They compared ITS sequences from *Rhizopogon* mycorrhizae of bishop pine soil bioassay samples to known sequences of *Rhizopogon* basidiocarps, including holotype and paratype sequences (see *Amylopogon* clade II in Kjøller and Bruns 2003). At the writing of Kjøller and Bruns (2003) there was no ITS sequence match for the clade identified as *Rhizopogon* subgen. *Amylopogon* clade II. We found basidiocarp matches to the bioassay sequences at the location in Santa Barbara Co. where the soil for the bioassays was collected (data not shown) and subsequently at other locations in southern California.

Acknowledgments

Members of the North American Truffling Society found most of the collections of *Rhizopogon ater*; the enthusiastic participation of NATS members in individual and group forays has contributed significantly to knowledge of North American hypogeous fungi. We thank Dr. Zoltán Bratek and Dr. Jason Hoeksema for reviewing the manuscript and whose comments increased the quality of the manuscript; Dr. Else Vellinga for valuable comments on an earlier version of the manuscript; Don Canestro for help as a guide at the University of California Rancho Marino Natural Reserve, and the Torrey Pines State Reserve and the UC Rancho Marino Natural Reserve for permission to collect fungal specimens. This study was funded in part from a University of California Natural Reserve System Mildred E. Mathias Graduate Student Research Grant and Mycological Society of San Francisco Esther Colton Whited-Harry D. Thiers Scholarship to LCG. Trappe's participation in the research was supported in part by the U. S. Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon.

Literature cited

- Bidartondo MI, Bruns TD. 2002. Fine-level mycorrhizal specificity in the *Monotropoideae* (*Ericaceae*): specificity for fungal species groups. *Mol Ecol* 11: 557–569.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. *Mol Ecol* 2:113–118.

- Grubisha LC, Trappe JM, Molina R, Spatafora JW. 2002. Biology of the ectomycorrhizal genus, *Rhizopogon* VI. Re-examination of infrageneric relationships inferred from phylogenetic analyses of internal transcribed spacer sequences. *Mycologia* 94: 607–619.
- Kjøller R, Bruns TD. 2003. *Rhizopogon* spore bank communities: within and among California pine forests. *Mycologia* 95: 603–613.
- Kretzer AM, Luoma DL, Molina R, Spatafora JW. 2003 Taxonomy of the *Rhizopogon vinicolor* species complex based on analysis of ITS sequences and microsatellite loci. *Mycologia* 95:480–487.
- Molina R, Trappe JM, Grubisha LC, Spatafora JW. 1999. *Rhizopogon*. In Cairney JWG, Chambers SM (eds.), *Ectomycorrhizal fungi: key genera in profile*. Springer Verlag, Heidelberg. pp. 129–161.
- Smith AH, Harrison KA. 1968. Some new species and distribution records of *Rhizopogon* in North America. *Can J Bot* 46 : 882899.
- Smith AH, Zeller SM. 1966. A preliminary account of the North American species of *Rhizopogon*. *Mem New York Bot Gard* 14: 1–178. Swofford DL. 2001. PAUP* Phylogenetic analysis using parsimony. Sinauer Associates, Sunderland, MA.
- Trappe JM. 1965. Tuberculate mycorrhizae of Douglas-fir. *Forest Sci* 11: 27-32.
- Zak B. 1971. Characterization and classification of mycorrhizae of Douglas-fir. II. *Pseudotsuga menziesii* and *Rhizopogon vinicolor*. *Can J Bot* 49: 1079–1084.

Coprophilous Mycobiota of Oman

ABDULKADIR E. ELSHAFIE

elshafie@squ.edu.om

*Department of Biology, College of Science, Sultan Qaboos University
PO Box 36 Al-Khod, Sultanate of Oman PC123*

Abstract—The coprophilous fungal mycobiota of the Sultanate of Oman was surveyed. Its distribution among the different sites and dung types was investigated. Forty-five species belonging to 25 genera are reported. The genera belong to the Discomycetes, Loculoascomycetes, Pyrenomycetes, Plectomycetes, Zygomycetes, Basidiomycetes and Myxomycetes. Most of the genera and species are new records for Oman. Twenty-one species are new records for the Arabian Peninsula and four are new records for Asia. The full text is included on the online database. <http://www.mycotaxon.com/resources/weblists.html>

Key Words—camels, cattle, goats, coprophilous fungi, survey

Introduction

Little is known about the coprophilous fungi of the Arabian Peninsula (Ahmed et.al. 1971a,b; Abdullah et al. 1976, 1978; Abdullah 1982; Bokhary 1985, 1986, 1987; Bokhary & Parvez 1986). No thorough study has been carried out on the coprophilous fungi of Oman.

The purpose of this online database is to document the coprophilous mycobiota of an arid environment and compare its distribution among the sites and dung types of Oman. The database will serve as a nucleus for the mycobiota of Oman and the Arabian Peninsula.

Materials and Methods

One hundred and ten dung samples were collected from different sites in the Sultanate of Oman. Each sample was soaked in distilled water for a few minutes and placed in a sterile glass dish containing sterilized moistened absorbent cotton lined with wet filter papers. The dishes were incubated at $24 \pm 2^\circ\text{C}$. Fungi that developed on the dung were examined and identified.

Results and Discussion

The incidence of occurrence, distribution of 45 species belonging to 25 genera are reported and displayed on the online database. Most of the genera and species are new

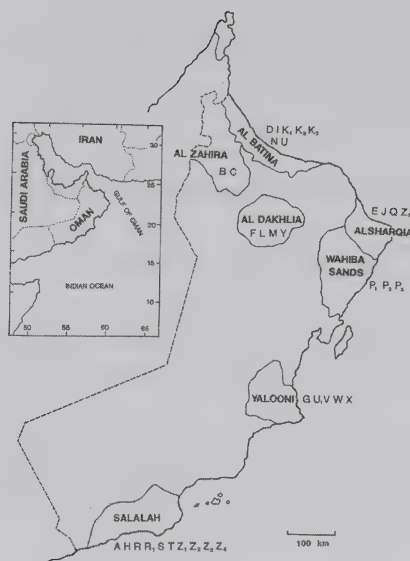


Fig.1 Distribution of coprophilous fungi in different sites in Oman

records for Oman. The genera are distributed as follows: Discomycetes (8 genera, 19 species); Loculoascomycetes (3 genera, 6 species); Pyrenomycetes (9 genera, 15 species); Plectomycetes (2 genera, 2 species); Myxomycetes, Basidiomycetes, and Zygomycetes (one genus, one species). Species of Discomycetes and Pyrenomycetes are the most common (75.5%).

Most of the fungal species were very rare and were found in less than 5% of dung examined. The species that were extremely common ($\geq 31\%$) were *Sporormiella minima* and *Iodophanus carneus*.

The distributions of the fungal species among the sites are displayed on the online database. Some fungi were found only in one site while others were distributed in all sites.

The distribution of the fungal species among the dung types of animals is also displayed on the online database. Twenty-seven species were found on camel dung, 24 on goat dung, 16 on cattle dung and 1-7 species on the dung of other animals. Some fungi were found only on one dung type while others were found on more than one. Some species are new records to the Arabian Peninsula and/or to Asia. Some dung types are new substrates.

Some of the seven genera of Discomycetes found on different dung types in this study are cosmopolitan and were also found in temperate and tropical habitats.

The most abundant fungi we found in our study were *Sporormiella minima*, *Iodophanus carneus*, *Coprotus disculus*, *C. granuliformis*, *C. leucopocillum* and *Chaetomium globosum*. The majority of these species are common and have been reported in East Africa. (Khan & Cain 1972, 1979; Caretta et al., 1998; Carter & Khan 1982).

Acknowledgements

I would like to thank Dr J C Krug, Department of Botany, University of Toronto, Ontario, Canada, and Dr. Ann Bell, 45, Gurney Road, Lower Hutt, New Zealand for reading the manuscript and for their valuable suggestions. I would also like to acknowledge Nomenclature Editor Dr. Shaun Pennycook for helpful nomenclatural advice.

Literature cited

- Abdullah SK. 1982. Coprophilous mycoflora on different dung types in Southern desert of Iraq. *Sydowia* **35**: 1-5.
- Abdullah SK, Ismail ALS, Rattan SS. 1976. New and interesting coprophilous fungi from Iraq. *Nova Hedwigia* **28**: 241-250.
- Abdullah SK, Rattan SS. 1978. *Zygopleurage*, *Tripterosporella* and *Podospora* (Sordariaceae: Pyrenomycetes) in Iraq. *Mycotaxon* **7**: 102-116.
- Ahmed SF, Ismail ALS, Abdullah SK. 1971a. Contribution to the fungi of Iraq I Coprophilous fungi. *Bull. Biol. Res. Centre (Baghdad)*. **5**: 1-16.
- Ahmed SF, Ismail ALS, Abdullah SK. 1971b. Contribution to the fungi of Iraq II. Coprophilous fungi. *Bull. Biol. Res. Centre (Baghdad)*. **5**: 16-32.
- Bokhary HA. 1985. Coprophilous fungal succession on camel dung. *Arab Gulf J. Sci. Res.* **3**: 277-284.
- Bokhary HA. 1986. Coprophilous fungi of Saudi Arabia 2. Occurrence of coprophilous fungi on camel, sheep and goat dung. *Proc. Saudi Biol. Soc.* **9**: 3-1
- Bokhary HA. 1987. Coprophilous fungi of Saudi Arabia 1. Camel. *J. Coll. Sci., King Saud Univ.* **18**: 29-41.
- Bokhary HA, Parvez S. 1986. Coprophilous fungi of Saudi Arabia 3. Coprophilous fungi of cow and rabbit dung. *Proc. Saudi. Biol. Soc.* **9**: 15-24
- Caretta G, Piontelli E, Savino E, Bulgheroni A. 1998. Some coprophilous fungi from Kenya. *Mycopathologia* **142**: 125-134.
- Carter A, Khan RS. 1982. New and interesting *Chaetomium* species from East Africa. *Can. J. Bot.* **60**: 1253-1262.
- Khan RS, Cain RF. 1972. Five new species of *Podospora* from East Africa. *Can. J. Bot.* **50**: 1649-1661.
- Khan RS, Cain RF. 1979. The genera *Sporormiella* and *Sporormia* in East Africa. *Can. J. Bot.* **57**: 1174-1186.

Six new lichen records from Turkey

KENAN YAZICI*

kcagri_1997@yahoo.com

Karadeniz Technical University, Giresun Science and Art Faculty, Biology
Department, Giresun, Turkey

ALI ASLAN

aliaslan@atauni.edu.tr

Biology Department, Kazım Karabekir Education Faculty, Atatürk University
Erzurum, Turkey

Abstract—Six species of lichenized fungi, *Acarospora modenensis*, *Aspicilia recedens*, *Echinoplaca epiphylla*, *Lecanora graeca*, *Lepraria cacuminum* and *Parmotrema austrosinense* are reported as new to the lichen flora of Turkey. For each a short description is presented.

Keywords—Ascomycetes, flora, Giresun, MustafaKemalpaşa, Trabzon

Interest in the lichen flora of Turkey has greatly increased in recent years (Aslan 2000, Aslan et al. 2002a, 2002 b, John & Breuss 2004, Yazıcı 1999a, Yazıcı & Aslan 2002, Yazıcı & Aslan 2003, Yazıcı et al. 2004). In previous studies on the Northeastern region, John and Breuss (2004) and Steiner (1909) reported 42 species for Giresun, Yazıcı (1999b) reported 78 species for Karacabey (Bursa), and Yazıcı et al. (2004) 4 species for MustafaKemalpaşa (Bursa). So far in the whole of Trabzon 502 species have been reported (John 1995 and references therein, John & Breuss 2004, Szatala 1960, Yazıcı 1999a).

The present report is based on samples collected on three different stations in Bursa, Giresun and Trabzon provinces between 26 August 2003 and 16 August 2004. A stereo microscope, a compound microscope and the standard spot tests were used in the identification of the samples, together with the following references: Clauzade & Roux (1985), Louwhoff & Elix (2002), Lohtander (1995), Lucking (1992), Poelt (1974), Purvis et al. (1992) and Wirth (1995). *Echinoplaca epiphylla* has been stored in the herbarium of Kazım Karabekir Faculty of Education, Atatürk University, Erzurum, Biology Department and the other samples in the herbarium of Biology Department, Giresun Science and Art Faculty, Karadeniz Technical University.

Acarospora modenensis H. Magn.

Thallus indeterminate, areolate; areoles dispersed or subcontiguous among the unevennesses of the stone, pallid or obscure red-grey brown, round, convex or

subplane or rarely a few grouped, 0.5–0.7(–1) mm wide, 0.3–0.4 mm thick, smooth, widely attached to the stone. Upper cortex 25–35(–60) μm thick, varying in thickness, translucent, exterior 5–7 μm dark brown, amorphous stratum rarely reaching 15 μm in thickness. Cells rather distinct in water, 2–3 μm in diam., irregularly arranged, with somewhat thickened walls, apices at the surface swollen, 3–4 μm broad, forming a dark brown line. Gonidia 6–9 μm in diam., forming a 60–85(–165) μm thick stratum with uneven surface, sometimes $\pm$ distinctly interrupted. Medulla white, 100–200 μm thick, hyphae rather lax, 3–5 μm in diam., rather thin walled, with $\pm$ round or elongate, distinct lumina. Lower side pale, $\pm$ thinly corticated. Apothecia rarely 2–4 in one areole, usually impressed, disc 0.3–0.6(–0.7) mm broad, quite smooth, often irregular in shape, surrounded by the usually prominent margin of the areole as a thick wall. Excipulum $\pm$ distinct, 15–20 μm thick, at the surface poorly or not developed, I–. Hypothecium ca. 50 μm thick with subhymenium 100–130 μm , I+ blue. Hymenium 70–80(–90) μm high, I+ dark blue, upper 15 μm gradually dark brown. Paraphyses in water not well discrete, coherent, 2–2.5 μm thick, with distinct septa in water, the apices in K swollen, brown, 3–4 μm thick. Asci rarely well developed. Spores about 4–5.5 x (1.8–)2–2.5 μm , ellipsoid, partly somewhat broadly ellipsoid. Pycnidia not found. Medulla K–, P–, C–.

Grows on sandstone without accompanying species. Known from Sweden, England, Italy and Australia.

Trabzon: Düzköy, Beypınar high plateau, on siliceous rock, at 700 m, 40° 48' N, 39° 20' E, 15 August 2004, Yazici 1255.

Aspicilia recedens (Taylor) Arnold

Thallus thick, loosely warted to cracked-areolate, dark grey, without isidia or soralia. Apothecia 0.3–1.0 mm diam., round, numerous, crowded; thalline exciple thin, persistent; true exciple pseudoparenchymatous, cells 5–8 x 3–5 μm ; disc dark brown-black, matt, flat, not pruinose; hypothecium with an algal layer below, hymenium colourless, epithecium olive green. Spores (9–)12–14 x 7–9 μm . Cortex and medulla P–, K–.

Grows on rocks by the seashore; found only once. Known in Europe from Sweden, Norway, Finland, Ireland, UK, Portugal, Germany, Poland, Ukraine, Romania and Denmark.

Trabzon: Düzköy, Beypınar high plateau, on siliceous rock, at 1700 m, 40° 48' N, 39° 20' E, 15 August 2004, Yazici 1257.

Echinoplaca epiphylla Fée

Thallus foliicolous, usually 5–10 mm diam., sometimes up to 15 mm diam., rounded, continuous or dispersed, verrucose to rugose, greyish-green to whitish grey, usually slightly nitid, 15–30 μm thick, encrusted with colourless crystals, usually furnished with white, tapering hairs, 0.3–0.8 mm long; corticiform layer 3–4 μm thick. Verrucae 0.05–0.1 mm across, irregular, often $\pm$ confluent, low, whitish. Hypothallus indistinct. Apothecia adnate, 0.2–0.4 mm diam., emarginate; disc pale to dark yellow or pale brown, non-pruinose, plane; excipulum sometimes faintly apparent around the

hymenium, resembling that of *Echinoplaca leucotrichoides*, but its lateral part usually not more than 100–150 μm broad and 40 μm thick. Algiferous thallus tissue below most of the apothecium. Hypothecium 5–10 μm thick, uncoloured. Hymenium 55–75 μm high, uncoloured or yellowish, K+ pale yellowish to intensely yellow; epithecium pale yellowish, 2–4 μm thick. Paraphyses 1 μm thick, richly branched and anastomosing. Asci clavate to clavate, 40–75 x 24–52 μm . Spores single (rarely 2 per ascus), muriform, with numerous cells, broadly ellipsoid, 36–70 x 20–48 μm . Symbiotic alga a species of *Chlorococcaceae*, cells globose, 5–10 μm diam.

This species is pantropic, with an isolated outpost on the East coast of the Black Sea. Known from Honduras, Guatemala, Costa Rica, British Guiana, French Guiana, Ecuador, Peru, Brasil, Tanzania, East Africa (Kenya), Java, The Philippines, New Guinea, New Caledonia, The Fiji Islands, Thailand, Japan, China, Australia, Sweden and North America.

Giresun: Center, Çatak Area of Mesudiye village, on *Buxus colchica* leaves, at 150 m, 40° 25' N, 38° 28' E, 10 September 2004, Aslan 1260.

Lecanora graeca J. Steiner

Thallus crustose, grey to yellow-green, distinct, cracked areolate, without soredia, marginal lobes rigid, 2–3(–5) mm long, thickish, at first often curved later $\pm$ cross-cracked, frequently some what recurved at the front, margins especially of the central areoles often blue-black bordered. Apothecia large, irregularly rounded, sunken to somewhat projecting, often areole-like, one per areola. Spores 9–13 x 5–8 μm . Medulla K+ red, C–, P+ yellow, Cortex K–.

Grows mostly on calcareous rock on level or sloping faces, in the Mediterranean region, above all in the east, very scattered. Known from Greece. Tunisia, Sweden and Italy.

Trabzon: Düzköy, Beypinar high plateau, on siliceous rock, at 1700 m, 40° 48' N, 39° 20' E, 15 August 2004, Yazici 1263.

Lepraria cacuminum (A.Massal.) Kümerl. & Leukert

Thallus crustose-leprose, diffuse, forming a thick, compactly packed, irregular patches; or a non-areolate crust, yellowish-white to grey; surface not corticate, a mass of coarse, spherical granules to 0.4 μm diam., or eroded to leave a leprose membrane; soredia with or without short projecting hyphae; margin effuse, rarely sublobed; medulla white, not distinct; lowerside with a weft of loosely entangled hyphae forming a thin, brown hypothallus. Thallus P– or + yellow, K+ yellow, C– (atranorin, $\pm$ porphyritic acid, roccellic acid and fatty acids).

Grows on acid, mossy rocks, also on acid bark, soil and other lichens. Known from temperate-arctic zones of both Hemispheres, in Europe from the UK, France, Estonia, Finland and Russia.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on mosses, at 600 m, 39° 03' N, 28° 19' E, 26 August 2003, Yazici 1244.

Parmotrema austrosinense (Zahlbr.) Hale

Thallus foliose with broad lobes, loosely adnate, 5–8 cm wide, lobes rounded, 10–30 mm wide, margins often ascending, eciliate; upper surface pale grey to grey-green, emaculate to faintly maculate soresiate; soralia marginal to submarginal, capitate to wavy, linear or rounded, $\pm$ diffuse, occasionally produced on pustules. No isidial initials present. Medulla white (sometimes with patches of orange-red skyrin or other anthraquinones near the lower cortex), lower surface black in the center, with a brown or partly white, erhizinate marginal zone, sparsely rhizinate, rhizines simple, black. Apothecia and pycnidia not seen. Cortex K+ yellow; medulla K–, P–, C+ red, KC+ red.

Grows on tree trunks in well lit sites. Known from Argentina, Brazil, Thailand, Mexico, Australia, England, Japan, South and North America, Africa (Sudan, Ethiopia, Tanzania) and China.

Trabzon: Düzköy, Beypınar high plateau, on *Picea orientalis*, at 1700 m, 40° 48' N, 39° 20' E, 15 August 2004, Yazici 1252.

Acknowledgements

We are grateful to Dr. André Aptroot and Dr. Harrie Sipman for linguistic revision and helpful comments on an early draft of this paper. We want to thank Dr. Gregorio Aragón (Madrid, Spain) for the identification of *Aspicilia recedens*, Dr. Roman Turk (Salzburg, Austria) for *Lecanora graeca*, Dr. Javier Etayo (Navarra, Spain) for *Parmotrema austrosinense*, and Dr. Antonin Vězda (Brno, Czech Republic) for *Echinoplaca epiphylla*.

References

- Aslan A. 2000: Lichens from the Regions of Artvin, Erzurum and Kars (Turkey). *Israel J. Plant Sci.* 48: 143–155.
- Aslan A, Yazıcı K, Karagöz Y. 2002a: Lichen flora of the Murgul District (Artvin, Turkey). *Israel J. Plant Sci.* 50: 77–81.
- Aslan A, Aptroot A, Yazıcı K. 2002b: New lichens from Turkey. *Mycotaxon* 84: 277–280.
- Clauzade G, Roux C. 1985: Likenoj de Okcidenta Europo.-Bull. Soc. Bot.u Centre-Ouest, N. S., No. Spécial 7. Rouen.
- John V. 1995: Flechten der Türkei IV. Ergänzungen zum die Türkei betreffende lichenologische Schrifttum. Neunkirchen.
- John V, Breuss O. 2004: Flechten der Östlichen Schwarzmeer-Region in der Türkei (Blam-Exkursion 1997). *Herzogia* 17: 137–156.
- Lohtander K. 1995: The lichen genus *Leproloma* in Finland and some notes on the *Lepraria neglecta* group. *Ann. Bot. Fennici* 32: 49–54.
- Louwhoff SHJJ, Elix JA. 2002: *Hypotrachyna* (Parmeliaceae) and allied genera in Papua New Guinea. *Biblioth. Lichenol.* 81: 1–150.
- Lücking R. 1992: Follicolous Lichens. A Contribution to the Knowledge of the Lichen Flora of Costa Rica, Central America. *Nova Hedwigia* 104: 1–79.
- Poelt J. 1974: Bestimmungsschlüssel Europäischer Flechten. J. Cramer, Lehre.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992: The Lichen Flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.

- Steiner J. 1909: Lichenes. In: v. Handel-Mazetti. Ergebnisse einer botanischen Reise in das Pontische Randgebirge im Sanshak Trapezunt. Ann. Naturhist. Hofmus. Wien 23: 107–123.
- Szatala Ö. 1960: Lichenes Turciae asiaticae ab Victor Pietschmann collecti. Sydowia 14: 312–325.
- Wirth V. 1995: Die Flechten Baden Württenbergs. Teil 1–2. Ulmer, Stuttgart.
- Yazıcı K. 1999a: Lichen flora of Trabzon. Turk. J. Bot. 23: 97–112.
- Yazıcı K. 1999b: Lichen species in the north of Karacabey County, Bursa Province, Turkey. Turk. J. Bot. 23: 271–276.
- Yazıcı K, Aslan A. 2002: New records for the lichen flora of Turkey. Turk. J. Bot. 26: 117–118.
- Yazıcı K, Aslan A. 2003: Lichens from the Regions of Gümüşhane, Erzincan and Bayburt (Turkey). Cryptogamie, Mycol. 24: 287–300.
- Yazıcı K, Aslan A, Aptroot A. 2004: Four new lichen species from Turkey. Mycotaxon 90: 177–180.

Five trans-septate species of *Hemithecium* from India

URMILA MAKHIJA, ARCHANA DUBE,
BHARATI ADAWADKAR & GAYATRI CHITALE

UV_Makhija@hotmail.com
Agharkar Research Institute
G.G. Agarkar Road, Pune 411004 India

Abstract—Five species of the lichen genus *Hemithecium* have been recorded from India, including the three new species *H. amboliense*, *H. consociatum*, and *H. norsticticum* and the new combination *H. nakanishianum*. A key to all species of *Hemithecium* thus far known from India is also provided.

Keywords—ascomycetes, taxonomy, *Graphidaceae*

Introduction

Staiger (2002) in her recent treatment of the lichen family *Graphidaceae* reintroduced the genus *Hemithecium* Trevis. *Hemithecium* is distinguished from the closely related new genus *Platythecium* Staiger (2002) and the other members of this family by: labia well developed, convergent; exciple uncarbonized, mostly distinctly crenate and with internal striae; disc not visible; the hyphae forming the lateral exciple/the labia are puffy/swollen and turn I+ brown/reddish-brown while *Platythecium* is characterized by: exciple uncarbonized, divergent, carbonization restricted to the base, lateral exciple only poorly developed forming a narrow brownish layer; disc visible in surface view, disc brown, yellowish, flesh-coloured or transparent, without or with little pruina. So far eight species of *Hemithecium* have been recorded from India (Adawadkar & Makhija, 2005; Makhija & Adawadkar, 2005).

As a result of our continuing investigations in the lichen family *Graphidaceae*, based on the examination of over 500 specimens collected from the Maharashtra state of India, we have recorded five species of the genus *Hemithecium*, three of them are new, namely *H. amboliense*, *H. consociatum*, and *H. norsticticum*, and a new combination, namely *H. nakanishianum*. *Hemithecium aphanes* was earlier recorded as *Graphis aphanes* (Patwardhan & Kulkarni 1976). A key to all hyaline, trans-septate species of *Hemithecium* so far known from India has also been given.

Materials and Methods

In the present work chemical constituents were identified by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970; Culberson 1972; White & James 1985) with the solvent systems benzene-dioxane-acetic

acid (180:45:5), toluene-ethylacetate-formic acid (139:83:8) and toluene-acetic acid (200:30). All specimens were examined under UV light (365 nm). All the specimens examined are deposited in Ajrekar Mycological Herbarium (AMH).

Key to all known trans-septate species of *Hemithecium* from India

- 1a. Ascomata immersed in elevated wart-like structures, (not in stroma). (*Thallus creamish to buff; ascomata 0.3–1.5 mm long; exciple entire to striate, non carbonized, present below; ascospores 21–53 x 6–9 µm; constictic, norstictic and stictic acids present.*) *H. consociatum*
- 1b. Ascomata not in wart-like structures 2
- 2a. Ascospores more than 100 µm long 3
- 2b. Ascospores less than 100 µm long 4
- 3a. Ascomata 6–15 mm long, robust, branched; exciple colourless to yellowish-brown throughout, with subverrucose margin, heavily crenate, heavy deposition of crystals in crenation; ascospores 10–25-trans-septate, (45–) 52–122 x 8–12 µm; constictic, norstictic and stictic acids present *H. nagalandicum*
- 3b. Ascomata 2–9 (–12) mm long, emergent, sparsely branched; exciple 3–4 striate on each side, present below, apically carbonized; ascospores 13–21-trans-septate, 49–112 x 7–14 µm; constictic, norstictic and stictic acids present *H. amboliense*
- 4a. Protocetraric acid present. (*Thallus dull yellow; ascomata 0.5–6 mm long, simple to branched, immersed; exciple entire; ascospores 9–12-trans-septate, 29–42 x 4–6 µm; protocetraric, stictic and constictic acids present*) *H. fulvescens*
- 4b. Protocetraric acid absent 5
- 5a. Ascospores more than 50 µm long 6
- 5b. Ascospores less than 50 µm long 9
- 6a. Ascomata less than 5 mm long. (*Thallus greenish stramineous, rough; ascomata 1–4 mm long, immersed to slightly raised; exciple entire, woody brown, present below; ascospores 15–22-trans-septate, 63–88 x 6–8 µm; constictic, salazinic, and stictic acids present*) *H. scariosum*
- 6b. Ascomata more than 5 mm long 7
- 7a. Only norstictic acid present. (*Thallus grayish-white; ascomata 1–9 mm long, concolorous; exciple internally striate, present below, occasionally slightly carbonized at the apex; ascospores 25–56 x 7–8 µm; norstictic acid present*) . . . *H. norsticticum*
- 7b. Norstictic and other acids present 8
- 8a. Thallus buff to whitish-green; ascomata 0.5–10 mm long, simple or rarely branched, immersed to semi-emergent; exciple with 2–4 internal striae, present at the base; ascospores 10–14-trans-septate, 25–67(–80) x 11–12 µm (upto 100 µm long in holotype); constictic, norstictic and stictic acids present. *H. aphanes*

- 8b.** Thallus greenish glaucous to pale olivaceous buff; ascomata 2–7 mm long, simple to dendroidly branched; exciple entire to indistinctly striate, present at the base; ascospores 8–10 (–15)-transeptate, 30–40(–60) x 6–9 μm ; constictic, norstictic (trace), and stictic acids present *H. nakanishianum*
- 9a.** Norstictic acid present **10**
- 9b.** Norstictic acid absent **11**
- 10a.** Thallus off-white, pale beige; ascomata 0.5–1.5 mm long, delicate, simple to radially to irregularly branched, scattered; disc dark reddish-brown, epruinose; exciple entire; ascospores 8–9-transeptate, 17–25 x 3–4 μm ; stictic, consalazinic and norstictic (trace) acids present *H. pulchellum*
- 10b.** Thallus greenish gray; ascomata 0.2–2 mm long, simple, triradiate or irregularly branched; disc black, pruinose; exciple entire; ascospores 10–14-trans-septate, 33–46 x 6–8 μm ; norstictic and stictic acids present. *H. balaghatense*
- 11a.** Ascomata short less than 5 mm long; testacein present. (*Thallus whitish, distinctly warty, farinaceous; ascomata 0.5–3 mm long, simple to branched, immersed; exciple entire, orange brown, internal striae, present at the base; ascospores 5–7-trans-septate, 21–29 x 4–5 μm ; consalazinic acid, testacein A and testacein B present.*) *H. staigeriae*
- 11b.** Ascomata more than 5 mm long; testacein absent **12**
- 12a.** Thallus brownish-yellow, olivaceous, glossy; ascomata 1–13 mm long, simple to branched, immersed, acute ends; disc pale brown; exciple entire, present at the base; ascospores 7–9-trans-septate, 21–33 x 3–4 μm ; constictic and stictic acids present *H. aphaneomicrosporum*
- 12b.** Thallus whitish-green, rough; ascomata 3–7 mm long, light brown, mostly simple; disc reddish-orange; exciple entire, present at the base; ascospores 6–7-trans-septate, 16–21 x 4–5 μm ; stictic acid present *H. croceum*

Taxonomic descriptions

Hemithecium amboliense Makhija & Dube sp. nov.

Figure 1

Similis *Hemithecium nakanishianum*, *sed ascosporis majoribus differt.*

Etymology: From the latin *ensis*, a place of origin, and Amboli, the type locality.

Holotype here designated–**Maharashtra State:** Sindhudurg District, Amboli, 28.9.1976, P.G. Patwardhan & U.V. Makhija, 76.1260; holotype: AMH.

Thallus greenish-gray, glaucous, continuous, smooth, cracked, thick, delimited by black hypothaloidal region at the periphery. **Ascomata** lirelline, semi-emergent to distinctly emergent, concolorous with the thallus or pale woody brown, straight or curved, flexuose, simple to sparsely branched, 2–9 (–12 mm) long, 0.2–0.7 mm broad, terminally subobtuse. **Disc** narrow, slit-like. **Exciple** entire or indistinctly 3–4 striate, convergent, reddish-brown to blackish-brown, complete, present at the base; completely non-carbonized, dark blackish brown or slightly carbonized at the tips. **Epithecium**

colourless to greenish-brown or brown. **Hymenium** hyaline, not inspersed, 53–49 μm high, 98–213 μm broad, I-, KI-. **Hypothecium** hyaline 35–49 μm . **Paraphyses** simple, thin. **Asci** 4–8 sporate, cylindrical. **Ascospores** hyaline, 13–21-trans-septate, 49–112 x 7–14 μm , I+ blue violet.

Chemistry—stictic, constictic, norstictic (trace) present.

Remarks—*Hemithecium amboliense* is distinguished from the closely related *H. nakanishianum* (*vide infra*) especially by its larger ascospores of 49–112 x 7–14 μm . In *H. nakanishianum* the ascospores are 30–40(–60) x 6–9 μm . The specimens examined were previously identified as *Graphis nakanishiana* (Patwardhan & Kulkarni 1979).

Hemithecium nagalandicum (Kr. P. Singh & G. P. Sinha) Adaw. & Makhija (Adawadkar & Makhija, 2005), a species from Nagaland, India resembles the new species in chemistry, but has larger, 6–15 mm long ascomata, exciple with verrucose, heavily crenate margin and slightly larger ascospores (52–122 x 8–12 μm).

The species was collected on *Mangifera indica* from Amboli in tropical semi-evergreen forest in open places on the road sides and is named after its locality. *H. amboliense* has been found associated with *H. nakanishianum*. The species seems to be restricted to Amboli.

Specimens examined—Maharashtra State: Sindhudurg District, Amboli, P.G. Patwardhan & U.V. Makhija, 76.1234B, 76.1235, 76.1256B, 76.160, 76.1261, 76.1263 (AMH).

Hemithecium aphanes (Mont. & Bosch) M. Nakan. & Kashiw.

Figure 3

Bull. Natn. Sci. Mus. Tokyo ser. B., **29(2)**: 85, 2003.

= *Graphis aphanes* Mont. & Bosch *Jungh. Plant. Junghuhn*. **4**: 474, 1855.

Remarks—The species was earlier recorded from Maharashtra as *Graphis aphanes* (Patwardhan & Kulkarni 1976). The species has been collected in semi-evergreen forest in open places on the road sides.

Specimens examined—Maharashtra State: Sindhudurg District, Amboli, U. V. Makhija, 76.1230; Kolhapur District, Vishalgad, Amba to Gajapur Road, C.R. Kulkarni & M.B. Nagarkar, 74.2204, 74.2205, 74.2207 (AMH).

Hemithecium consociatum Makhija & Dube **sp. nov.**

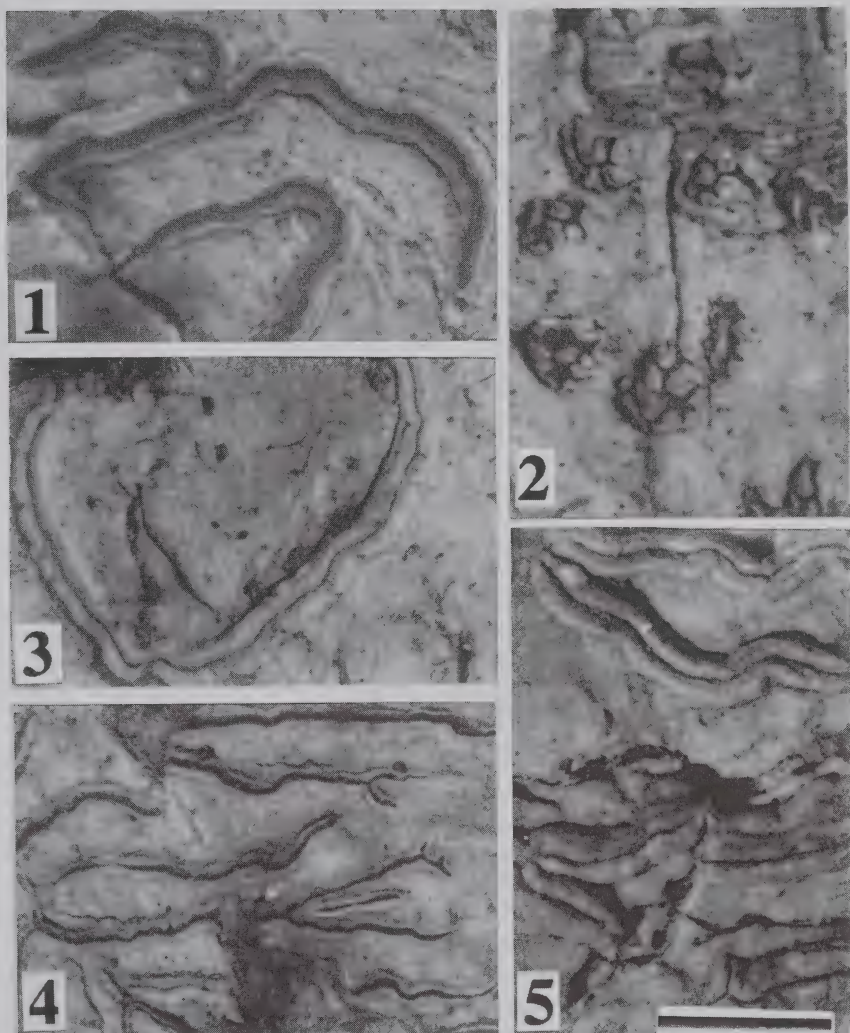
Figure 2

Species insignis ascomatis consociatis et immersis structura thallo verruciformis; ascosporis incolores, 7–13-trans-septatis, 21–53 x 7–10 μm ; acida consticticum, norsticticum et sticticum continens.

Etymology: from the latin *consociatus*, closely associated, connected, a reference to the ascomata immersed in a wart like structure.

Holotype here designated—Maharashtra State: Kolhapur District, on the way to Phonda ghat from Radhanagari, 12.10.2000, U.V. Makhija & V. A. Mantri, 00.262; holotype: AMH.

Thallus creamish to buff, smooth, cracked, moderately thick, surrounded by a thin black hypothallus. **Ascomata** lirelline, 0.3–1.5 mm long and 0.1–0.4 mm broad, simple to branched, 2–3 lirellae immersed in an elevated, linear, round or elongate, 0.7–2 mm long



Figures—1-5. Habit (Holotypes) 1. *Hemithecium amboliense*; 2. *H. consociatum*; 3. *H. aphanes*; 4. *H. nakanishianum*; 5. *H. norsticticum*. Bar = 2mm

and 0.5–0.7 mm broad, non-stromatic, wart like structure. **Disc** narrow to moderately broad, reddish black. **Exciple** orange brown, present at the base, non carbonized, rarely carbonized at the tips, and converging at the apical portion, entire to sometimes striate, covered by a thick thalline margin till the top. **Epithecium** greenish- black, 14–18 μ m thick. **Hymenium** hyaline, not inspersed, 74–112 μ m high and 70–245 μ m broad, I-, K/I-. **Hypothecium** hyaline, 11–21 μ m thick. **Paraphyses** simple, septate, thickened

and branched at the apices. **Asci** 8 sporate. **Ascospores** hyaline, fusiform to oblong, 7–13-trans-septate, 21–53 x 7–10 μm , I+ blue.

Chemistry—constictic, norstictic (trace) and stictic acids present.

Remarks—*Hemithecium consociatum* is characterized by its short, simple to branched lirellate ascomata immersed in elevated, linear, round or elongate, non-stromatic, wart like structures, trans-septate ascospores of 21–53 μm long and the presence of constictic, stictic and norstictic (in trace) acids in its thallus.

Thus the new species stands distinct among all species of *Hemithecium* and is not comparable with any other known species of this genus by virtue of its ascomata immersed in non-stromatic, wart like structures.

Hemithecium consociatum was collected in moist place on the road side trees.

Hemithecium nakanishianum (Patw. & C.R. Kulk.) Makhija & Dube **comb. nov.**

Figure 4

= *Graphis nakanishiana* Patw. & C.R. Kulk., *Norw. J. Bot.* **26**: 46 (1979)

Type—India, Karnataka, South Canara, Sringeri, C.R. Kulkarni & A.V. Prabhu, 74.3288; holotype: AMH (!)

Thallus greenish glaucous to pale olivaceous buff, continuous or cracked, smooth. **Ascomata** semi-emergent to emergent, concolorous with the thallus or pale woody brown, flexuose to dendroidly branched, 2.0–7.0 mm long, ends subobtuse to acute.

Disc narrow, slit-like. **Exciple** entire or indistinctly striate, convergent, crimson red to slaty, completely non-carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not interspersed, 120–180 μm high and 150–200 μm broad, I-, K/I- **Paraphyses** simple, thin, unbranched. **Asci** cylindrical, 4–8 sporate. **Ascospores** hyaline, 8–10 (-15)-trans-septate, 30–40(-60) x 6–9 μm I+ blue.

Chemistry—constictic, norstictic (trace) and stictic acids present.

Remarks—In the protologue to *Graphis nakanishiana* a large number of specimens were cited under this name by Patwardhan & Kulkarni (1979). The authors reported a “great range of variation in thallus colour, lirellae morphology (length, branching, and colour, nature of disc and labia) and size and number of locules of ascospores” and suggested that this was “possibly due to incomplete segregation of species by hybridization in a complex of two or more taxa”. Careful examination of these specimens, and additional specimens cited below, has resulted into the segregation of three distinct species namely *Hemithecium amboliense*, *H. aphanes*, *H. norsticticum* and the new combination *H. nakanishianum* which are described in this work. All the additional specimens cited are in AMH.

Hemithecium nakanishianum seems to be one of the most predominant and widely distributed species in Maharashtra. The species has been collected on road side trees in both moist and dry conditions.

Specimens examined—**Maharashtra State:** Kolhapur District, on the way to Kumbhi from Gaganavda, B.C. Behera & B.A. Adawadkar, 00.344, B.C. Behera & V. A. Mantri, 00.346; Phonda to Vaibhavwadi, B.A. Adawadkar & K.R. Randive, 00.331; Radhanagari to Phonda, U.V. Makhija & V.A. Mantri, 00.265, 00.270; on the way to Phonda from Radhanagari, U.V. Makhija & V.A. Mantri, 00.264, 0.266, 00.280; Panhala,

U.V. Makhija & V.A. Mantri, 00.381, 00.384, 00.389, 00.481; Panhala, *U.V. Makhija & V.A. Mantri* 00.391, 00.477, 00.478; Dongarwadi, *V.A. Mantri & K.R. Randive*, 00.134, 00.136; Dongarwadi,, *U.V. Makhija & B.C. Behera*, 00.131; Purandar fort, *C.R. Kulkarni*, 73.157; Lonavala, 00.86; Sinhadgad, *U.V. Makhija*, 00.53; Shirgaonkar Point, *U.V. Makhija & B.A. Adawadkar*, 00.224, 00.229, 00.230; Amboli to Shirgaonkar point, *U.V. Makhija & V.A. Mantri*, 00.225, 00.241; on the way from Amboli to Ajra, *U.V. Makhija*, 00.210; on the way to Sawantawadi from Amboli, *U.V. Makhija & B.A. Adawadkar*, 00.238, 00.239 (AMH).

***Hemithecium norsticticum* Makhija & Dube sp. nov.**

Figure 5

Similis Hemithecium aphanes sed acidum norsticticum continens vice acidum consticticum, norsticticum et sticticum differt.

Etymology: from the name of the lichen substance norstictic acid.

Holotype here designated—India, Maharashtra State, Bhimashankar, 29.9.1974, *M.B. Nagarkar & C.R. Kulkarni*, 74.784; holotype: AMH.

Thallus grayish-white to buff, glaucous, thin, smooth to cracked, sometimes warty, surrounded by thin, black, hypothallus. **Ascomata** lirelline, 1–9 mm long and 0.5 mm broad, simple to rarely branched, immersed to semi-emergent, straight to irregularly curved, flexuose, scattered, concolorous with the thallus, tapering, terminally acute to obtuse. **Disc** narrow, dark brown, 0.1–0.2 mm broad, epruinose. **Exciple** complete, present at the base, converging at the apical portion, internally striate, non carbonized, to rarely carbonized at tips. **Epithecium** dark brown to greenish-brown, 14–18 μ m thick. **Hymenium** hyaline, not interspersed, 53–81 μ m high and 158–210 μ m broad, I-, K/I-. **Hypothecium** hyaline, 10–18 μ m thick. **Paraphyses** simple, long, thin, filiform, septate. **Asci** 2-8 sporate. **Ascospores** hyaline, 7–14-trans-septate, 25–56 x 7–8 μ m, I+ blue.

Chemistry—norstictic acid present.

Remarks—*Hemithecium norsticticum* is similar to *H. aphanes* in its morphology and anatomy but differs from *H. aphanes* in containing norstictic acid in contrast to *H. aphanes* which contains constictic, norstictic and stictic acid in its thallus. *Hemithecium nakanishianum*, another species from India is very similar to *H. norsticticum* in exciple characters, ascospores size, but contains stictic and constictic acids with only traces of norstictic acid. The new species is distinguished from the chemically similar *H. oshioi* (M. Nakan.) M. Nakan. & Kashiw (Nakanishi *et al.* 2003) by the larger ascospores; in *H. oshioi* the ascospores are 20–30 x 7–9 μ m. The new species is found in dry deciduous forest as well as in semi evergreen forests and seems to be restricted to Maharashtra only.

Specimens examined—Maharashtra State: Pune District, Bhimashankar, *M.B. Nagarkar & C.R. Kulkarni*, 74.773, 74.778, 74.784, 74.786, 74.815; Dongarwadi, *U.V. Makhija & B.A. Adawadkar*, 00.137; Sinhadgad, *U.V. Makhija & B.A. Adawadkar*, 00.52; Malshej Ghat, Neemgiri, *U.V. Makhija & A.V. Bhosale*, 02.16, 02.20, 02.21, 02.22, 02.29, 02.30; Satara District, Mahabaleshwar, Dhobighat, *M.B. Nagarkar*, 74.76; Bombay point, *M.B. Nagarkar & P.G. Patwardhan*, 75A, 85.1855, 85.1856, 85.2937; Sindhudurg District, Amba, *C.R. Kulkarni & A.V. Prabhu*, 74.1336, 74.1644 (AMH).

Acknowledgement

We are grateful to Dr. A.W. Archer, National Herbarium of New South Wales, Australia and Dr. R Lücking, The Field Museum of Natural History, USA, for valuable comments on the manuscript. We are grateful to the Ministry of Environment and Forest, Government of India, New Delhi for the financial support.

Literature Cited

- Adawadkar B, Makhija, U. 2005. Some trans-septate species of the genera *Hemithecium* and *Platythecium* from India. *Mycotaxon* **92**: 387-394.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. *J. Chromatogr.* **72**: 113-125.
- Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr.* **46**: 85-93.
- Makhija U, Adawadkar B. 2005. Some additions to the *Graphidaceae* in the Andaman islands, India. *Mycotaxon* **91**: 347-352.
- Nakanishi M, Kashiwadani H, Moon KH. 2003. Taxonomical notes on Japanese *Graphidaceae* (Ascomycotina), including some new combinations. *Bull. Natn. Sci. Mus. Tokyo ser. B.*, **29**(2): 83-93.
- Patwardhan PG, Kulkarni CR. 1976. Some additions to the lichen flora of India IV: *Graphis* and *Graphina* (Family Graphidaceae). *Biovigyanam* **2**: 124.
- Patwardhan PG, Kulkarni CR. 1979. Some new taxa of the family *Graphidaceae* from western Ghats, Southwestern India. *Norw. J. Bot.* **26**: 45-52.
- Staiger B. 2002. Die Flechtenfamilie Graphidaceae: Studien in Richtung einer natürlicheren Gliederung. *Biblio. Lichenol.* **85**: 1-526.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *Bull. British Lichen Soc.* **57**: 1-41 (Suppl.).

***Leptogium diffractum* in Slovakia and Czech Republic (lichenized Ascomycota)**

ANNA GUTTOVÁ

anna.guttova@savba.sk

*Institute of Botany, Slovak Academy of Science
Dúbravská cesta 14 SK-845 23 Bratislava, Slovakia*

PER MAGNUS JØRGENSEN

*Arboretum and Botanical Garden, University of Bergen
Mildevegen 240 NO-5259 Hjellessad, Norway*

Abstract—Specimens assigned to *Leptogium diffractum* originating in Slovakia and Czech Republic were located and revised. The occurrence of the species in Slovakia is supported by one historic collection and one new finding, presented here. The rest of the material as well as Czech material represent *Collema parvum*. *L. diffractum* and its synonym *L. placodiellum* are lectotypified. Overall distribution and aspects of conservation evaluation are discussed.

Key words—*Collemataceae*, *Leptogium placodiellum*, cyanophilic lichens, types

Introduction

Leptogium diffractum is a tiny crustose cyanolichen. The minute placodioid thallus (1–1.5 cm diam.) is rimose-cracked, composed of rosette-like or irregularly arranged areoles and lobules ± 1 mm long. Dorsiventral areoles often ascend and subsequently die away. Their surface is delicately wrinkled. Apothecia are rarely produced. Coppins & Purvis (1992) give the following details: apothecial disc 0.2–0.5 mm diam., size of ellipsoid, muriform spores $15\text{--}30 \times 8\text{--}12 \mu\text{m}$. Production of vegetative diaspores has not been observed.

L. diffractum is currently regarded a European geoelement. It has been reported from Austria (Hafellner & Türk 2001), Benelux (Diederich et al. 2000), Bosnia-Herzegovina and Croatia (Kušan 1953), Estonia (Martin et al. 2000, Anonymous 2004), France (Degelius 1954, Ozenda & Clauzade 1970), Great Britain (Coppins & Purvis 1992), Hungary (Verseghegy 1994), Italy (Nimis 2003), Germany (Scholz 2000), Slovakia (Bielczyk et al. 2004), Spain (Aragón & Otálora 2004), Sweden (Santesson et al. 2004) and Ukraine (Coppins et al. 2001).

The species is confined to basic rock substrates. Aragón & Otálora (2004) are more specific, explaining that the rock is preferably dry and perpendicular, and they list further accompanying cyanolichens viz. *Collema cristatum*, *Leptogium massiliense*, *Placynthium hungaricum*, *P. subradiatum*, *P. tremniacum* or *Zahlbrucknerella calcarea*.

In Slovakia the species was considered *Vulnerable* (see IUCN Red List categories and criteria) due to scattered records. After the ongoing field research, it was placed into the category covering the taxa with deficient data (DD) in the latest version of the Red List of lichens (Pišút et al. 2001). It is also listed as *Vulnerable* in the Red List of Sweden (Gärdenfors 2005); in Great Britain, referring to post-1960 records, it is classified as nationally rare (Woods & Coppins 2003).

Materials and Methods

Specimens labelled as *Leptogium diffractum*, *Collema diffractum* or *Leptogium placodiellum* kept in the collections of the following institutions were studied: BM, BP, BRA, BR, BUC, BUCA, CL, GZU, H-NYL, KRAM, L, M, PAV, PRC, PRM, SAV, SLO, TNP, UPS, VBI, W, as well as private collections of A. Lackovičová (Bratislava, Slovakia), I. Pišút (Bratislava, Slovakia), A. Vězda (Brno, Czech Republic). Acronyms follow Index Herbariorum by Holmgren et al. (1990).

Morphological and anatomical characters of the specimens were investigated using light microscope and preparations in 10% aqueous KOH. Localities are fully cited. Alpha-numeric codes associated with localities refer to the UTM coordinates used in Slovakia. Nomenclature of the cited lichen names conforms Bielczyk et al. (2004).

Results

The species was reported from Slovakia from two orographic units. The collection from Belianske Tatry Mts. (Lojka 1869, Szatala 1930) is in poor condition (broken apart into pieces of ca 1 mm). Examination of the other specimen from Biele Karpaty Mts (Pišút 1981) showed that it represents another gelatinous lichen, *Collema parvum*, a species at first sight closely resembling *L. diffractum*. The dark grey to black colour of the *Collema* species, rounded lobes, widening towards the tips, abundant spherical isidia as well as the absence of a paraplectenchymatous cortex unambiguously differ from that of *L. diffractum*. The collection labelled as *L. diffractum* from the Czech Republic also belongs to *Collema parvum*.

Simultaneously, field research was carried out to determine whether the species is as rare as herbarium records indicate. In Slovakia the authors concentrated on limestone areas such as the southwest, north central, and central karst regions and the Jurassic-Early Cretaceous klippen belt. This belt initiates in Austria (north of Vienna), breaks the surface in southwest Slovakia (Podbranč), and then follows the Váh river northeast to Orava, near southern Poland. It then turns south, back into Slovakia in Červený

Kláštor (Pieniny Mts). Further in the east it sinks under the volcanic rocks of Vihorlat Mts, crossing the Ukrainian border before ending in Romania. In the Czech Republic, the main limestone islands were studied: Czech karst (Central), Moravian Karst and the Pavlovské vrchy hills in the southeast. Despite the number of localities with favourable conditions in both the countries, *L. diffractum* was recorded only once. In addition to this several tiny epilithic cyanolichens (from the genera *Lemmopsis*, *Psorotichia*, *Anema*), either new records for Slovakia, or previously undercollected, were found (cf. Guttová & Palice 2002, Guttová 2004). This fieldwork shows that *L. diffractum* is rare although it has not been possible to ascertain the cause of this. The species currently grows on perpendicular rock faces of the cliffs above the gorge Manínska tiesňava. The site features temperature inversion due to local geomorphology.

SELECTED SPECIMENS EXAMINED. *Leptogium diffractum*, An Kalkfelsen bei Lofer in Pinzgau, Krempelhuber, (L 0194179); *Leptogium placodiellum*, ad lapides calcareos, Cher, Châteauneuf, dans les vignes, 1863 Dr. Ripart (H-NYL P.M. 340); *Leptogium placodiellum*, Gallia, Châteauneuf, Ripart, (H-NYL P.M. 341); *Leptogium placodiellum*, ad lapides calcareos, Châteauneuf, 1863 Ripart (M 0059941). Crypt. Vind. 2448 (BP, BR, CL, GZU, W). **SLOVAKIA.** **Belianske Tatry Mts.**, Faixová (ut Feigsblösse), am Kalkfelsen, 1868 Lojka (W, LOJKA 1869, SZATALA 1930, LISICKÁ 2005); **Biele Karpaty Mts.**, ad saxa calcarea aprica in monte Chmeľová supra pag. Vršatecké Podhradie, alt. 800 m, 1971 Pišút (BRA, Pišút 1981) = *Collema parvum*, rev. A. Guttová; **Strážovské vrchy Mts.**, Manín, NNR Manínska tiesňava, Malý Manín, limestone ridge Jašteričí hrebeň, S exposed limestone walls, ca 500 m a. s. l., 10. 5. 2003 leg. A. Guttová, K. Kresáňová & J. Smatanová (SAV) (6877/c). **CZECH REPUBLIC.** **Drahanská vrchovina hills**, Blansko, „Rudické propadání“ prope Jedovnice, ad saxa calcarea, alt. 480 m s. m., 1973 Vězda (BRA, hb. Vězda) = *Collema parvum*, rev. A. Guttová.

The species and nomenclatural notes

Leptogium diffractum Kremp. ex Körb. – Parerga Lichenologica 1859–65: 424.

Type: Auf Kalkgerölle unter Buchen bei Prunn unweit Riedenburg im Altmühlthale.

– August 1863, Arnold (L 0194178), lectotype designated here.

= *Leptogium placodiellum* Nyl. ex Ripart – Bull. Soc. Bot. France 23: 269 (1876).

Type: Châteauneuf – pierre, d'un vieu mur au ruines dans des vignes, du côté du nord.
13 août 1863 Dr. Ripart (H-NYL 41135), lectotype designated here.

The species has been misunderstood and renamed throughout its history. *Leptogium diffractum* appeared first as a nomen nudum in Arnold (1861) who took up an unpublished Krempelhuber's name. However it was not validly published until Körber (1859–65: 424) who based his description on Arnold's sterile specimens (*Lichenes exsiccati*/ *Lichenes Jurae* 156b) (Arnold 1861) and those of Krempelhuber from Pinzgau.

We located and studied original material cited in the protologue. The specimen in *Lichenes exsiccati*/*Lichenes Jurae* 156b (L) contains well-developed, typical thalli both in initial (1–2 mm diam.) and adult phases (5–6 mm diam.). Apothecia are not developed. Cortical layer is continuous, covering upper and lower surface, where, sporadic rhizinae help to fix the areoles to the substrate. We select this specimen

0194178 (L) as a lectotype of the taxon according to ICBN, Art. 9.2. Krempelhuber's collection from Pinzgau (L) is a little piece of stone with 2 sterile thalli (3 and 4 mm diam.).

Leptogium diffractum is currently synonymized with *L. placodiellum* (e.g. Nimis 2003) and was linked with it since its introduction in the past. *L. placodiellum* was first used as a nomen nudum by Nylander in a footnote to the presumably related species *Pyrenidium actinellum* Nyl. (Nylander 1865, Crombie 1870) – “*Leptogium placodiellum* dixi *L. diffractum* Kphb. (*Flora* 1861, p. 258), quod nomen jam affini *Collemati* adhibitum fuit; a Dre. Ripart in Gallia centrali lectum est.” Ripart formally described the species (Ripart 1876). It was also him who pointed out that the newly described species might be identical with *L. diffractum*: “*M. Krempelhuber a publié, sous le nom de L. diffractum, une espèce trouvée par lui en Allemagne, également à l'état stérile, et qui est probablement la même que la nôtre*”. In his description he referred to the collection from Châteauneuf-sur-Cher “*sur les pierres du calcaire jurassique*”. We studied Ripart's material kept in H-NYL (3 specimens) and one duplicate kept in M comprising well developed, sterile thalli. It is identical with the above selected lectotype of *L. diffractum*. *L. placodiellum* accordingly is a younger synonym of *L. diffractum*. We designate the specimen 41135 as a lectotype of the name *L. placodiellum* following ICBN, Art. 9.2.

Interestingly, in his descriptive catalogue, Crombie (1894) chose the name *L. placodiellum* over *L. diffractum*. His argument was that even though the epithet *diffractum* has priority, it was already used in the combination *Collema diffractum* (Nylander 1857). Forssell (1885) however, and then Degelius (1954) or Moreno & Egea (1994) showed, that this combination denotes the crustose cyanolichen *Psorotichia diffracta* (Nyl.) Forssell.

Acknowledgements

The curators of the cited collections are thanked for their assistance, and L. Lőkös (Budapest) for kind and prompt help with literature. Peer reviewers Ch. Printzen (Frankfurt am Main), G. Thor (Uppsala) and I. Pišút (Bratislava) are acknowledged for critical comments to the manuscript. P. Lizoň and K. Marhold (Bratislava) advised regarding nomenclature. K. Harman and A. Davis (Kew) kindly revised English. The study was supported by Slovak grant agency APVT (no. 51-005102).

Literature cited

- Anonymous. 2004. Checklist of lichens and lichenicolous fungi of Estonia. Preliminary version 1 October 2004. <www.biologie.uni-hamburg.de/checklists/europe/estonia_1.htm>.
- Aragón G, Otálora MAG. 2004. Ecological and chorological novelties of the genus *Leptogium* in the Iberian Peninsula. *Nova Hedwigia* 78: 353-366.
- Arnold F. 1861. Die Lichenen des fränkischen Jura. (Schluss). *Flora* 17: 257-268.
- Bielczyk U, Lackovičová A, Farkas E, Lőkös L, Breuss O, Kondratyuk S. 2004. Checklist of lichens of the Western Carpathians. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

- Coppins BJ, Kondratyuk S, Khodosovtsev S, Wolseley P, Zelenko S. 2001. New for Crimea and Ukraine species of the lichens. *Ukrainian Botanical Journal* 58: 716-722.
- Coppins BJ, Purvis OW. 1992. *Leptogium*. In: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM [eds.], *The lichen flora of Great Britain and Ireland*. The British Lichen Society, The Natural History Museum, London, pp. 350-356.
- Crombie JM. 1870. *Lichenes Britannici seu Lichenum in Anglia, Scotia, et Hibernia Vigentium enumeratio, cum eorum stationibus et distributione*. Londini.
- Crombie JM. 1894. *A monograph of lichens found in Britain being a descriptive catalogue of the species in the herbarium of the British Museum*. Part 1. London.
- Degelius G. 1954. The lichen genus *Collema* in Europe. *Symb. Bot. Upsal.* 13/2: 1-499.
- Diederich E, Sérusiaux E. 2000. The lichens of Belgium and Luxembourg. An annotated checklist. *Musée National D'Histoire Naturelle*. Luxembourg.
- Forssell KBJ. 1885. Beiträge zur Kenntniss der Anatomie und Systematik der Gloeolichenen. *Nova Acta Regiae Societatis Scientiarum Upsaliensis*, Ser. 3/13: 1-118.
- Guttová A. 2004. Nové nálezy zaujímavějších lišajníkov Kysuckej vrchoviny (severozápadné Slovensko). *Bull. Slov. Bot. Spoločn., Bratislava, Supl.* 10: 91-95.
- Guttová A, Palice Z. 2002. Lišajníky Národného parku Muránska planina II – Javorníková dolina. *Výskum a ochrana prírody Muránskej planiny* 3: 53-68.
- Gärdenfors, U. (ed.) 2005. Rödlistade arter i Sverige 2005–The 2005 Red List of Swedish Species. *ArtDatabanken, SLU, Uppsala*.
- Hafellner J, Türk R. 2001. Die lichenisierten Pilze Österreichs – eine Checkliste der bisher nachgewiesenen Arten mit Verbreitungangaben. *Stapfia* 76: 1-167.
- Holmgren PK, Holmgren NH, Barnet L. 1990. *Index herbariorum*. Part I: The herbaria of the world. 86th ed. Bronx, New York Botanical Garden.
- Körber GW. 1859-65. *Parerga lichenologica*. Breslau.
- Kušan F. 1953. *Prodromus Flore Lišaja Jugoslavije*. Jugoslavenska Akademija Znanosti i umjetnosti. Zagreb.
- Lisická E. 2005. *The Lichens of the Tatry Mountains*. Veda, Bratislava.
- Lojka H. 1869. Bericht über eine lichenologische Reise in das nördliche Ungarn, unternommen im Sommer 1868. *Verh. Zool. Bot. Ges. Wien*, 19: 481-500.
- Martin L, Randle T, Martin J. 2000. Lichens of Vormsi Island. *Folia Cryptogamica Estonica* 36: 65-81.
- Moreno PP, Egea JM. 1994. El género *Psorotichia* y especies próximas en el sureste de España y norte de Africa. *Bull. Soc. Linn. Provence*, 45: 291-308.
- Nimis PL. 2003. Checklist of the lichens of Italy 3.0. University of Trieste, Dept. of Biology, IN3/0/2. <www.dbiodbs.univ.trieste.it>.
- Nylander W. 1857. *Prodromus lichenographiae Galliae et Algeriae*. *Act. Soc. Linn. Bordeaux* 21/3: 249-267.
- Nylander W. 1865. *Novitiae quaedam Lichenum Europaeorum variarum tribuum*. *Flora* 14: 209-213.
- Ozenda P, Clauzade G. 1970. *Les Lichens*. Masson et C^{ie}, Paris.
- Pišút I, Guttová A, Lackovičová A, Lisická E. 2001. Červený zoznam lišajníkov Slovenska (december 2001). *Ochr. Prír.* 20 (Suppl.): 23-30.
- Pišút I. 1981. Nachträge zur Kenntnis der Flechten der Slowakei 9. *Acta Rer. Natur. Mus. Nat. Slov., Bratislava*, 27: 11-15.
- Ripart M. 1876. Notice sur quelques espèces rares ou nouvelles de la flore cryptogamique du centre de la France (fin). *Bull. Soc. Bot. France* 23 : 258-270.

- Santesson, R., Moberg, R., Nordin, A., Tønsberg, T. & Vitikainen, O. 2004. Lichen-forming and lichenicolous fungi of Fennoscandia. Museum of Evolution, Uppsala University.
- Scholz P. 2000. Katalog der Flechten und flechtenbewohnenden Pilze Deutschlands. Bundesamt für Naturschutz, Bonn – Bad Godesberg.
- Szatala Ö. 1930. Lichenes Hungariae II. Gymnocarpae (Graphidinae, Cyclocarpineae: Lecanactidaceae - Peltigeraceae). Magyarország zuzmóflórája. Folia Crypt. 1: 833-928.
- Thor G, Arvidsson L. 1999. Rödlistade lavar i Sverige. Artfakta. ArtDatabanken, SLU, Uppsala.
- Verseghy K. 1994. Magyarország zuzmóflórájának Kézikönyve. Magyar Természettudományi Múzeum, Budapest.
- Woods RG, Coppins B J. 2003. A Conservation Evaluation of British Lichens. British Lichen Society, London.
- Zahlbruckner A. 1926. Lichenes (Flechten). In: Engler A. [ed.], Die natürlichen Pflanzenfamilien. 8. Band. Wilhelm Engelmann, Leipzig, pp. 1-270.

Taxonomic revision of the myxomycetes from Cuba deposited in the Farlow Herbarium (USA)M. CAMINO ¹ G. MORENO ² & A. CASTILLO ²¹*hajib@ceniai.inf.cu**Jardín Botánico Nacional de Cuba, Universidad de la Habana
Carretera El Rocío, Km 3.5. Calabazar, Boyero
C.P. 19230, Ciudad Habana, Cuba.*²*gabriel.moreno@uah.es aurelio@castillo@uah.es
Dpto. de Biología Vegetal (Botánica), Universidad de Alcalá
E-28871 Alcalá de Henares, Madrid, Spain.*

Abstract—A critical revision of the myxomycetes from Cuba deposited presently in the Farlow Herbarium (FH) is presented. The total number of examined specimens is 83, of which 13 could not be determined to species. These specimens were gathered mainly during the 19th century by Charles Wright in the course of expeditions he made to this island. All the species are discussed and, in the case of records of taxonomic or chorological interest, they are described. The determinations are reinforced by studies of the spore ornamentation by SEM, using the critical point method. Micrographs of the spore ornamentation of species little studied by SEM or that are of particular interest for the island biota are included.

Key words—chorology, Myxomycota, taxonomy, Neotropical myxobiota, SEM

Introduction

We consider that the revision of historic material as a necessary part of a detailed study of the Myxobiota of a country, representing a basic aspect in the compilation of existing information in herbaria and from the literature.

There are a few references to Cuban Myxomycetes prior to 1980 (Montagne 1845, Berkeley 1869, Masse 1892, Farr 1976), and most of these refer to specimens deposited in the Farlow Herbarium (FH) and in the National Fungus Collections (BPI) in the 19th century.

Most of the specimens deposited in the Gray Herbarium of Farlow Herbarium were collected by Charles Wright.

Asa Gray (1810–1888) could be regarded as the person who established systematic botany at Harvard and, to some extent, in the United States because he was well-known as the “Father of American Botany” and champion of Darwin’s theory of Natural Selection. As a result of Gray’s ties with European botanists, developed through correspondence, exchange of specimens and visits to Europe, combined with his network of collectors in North America, he was able to build a major herbarium, which became the nucleus of the current Gray Herbarium at Harvard University in Cambridge, Massachusetts.

Among the collectors was Charles Wright (1811-1885). Wright corresponded with Asa Gray, beginning in 1837 following his move to Texas. He traveled around the world in 1851 and collected numerous specimens from Texas, New Mexico, Arizona, Australia, Hong Kong, Japan, islands of the Bering Straits and Nicaragua.

From 1856 to 1867, Wright made many trips to Cuba. His work was described by the botanist August Grisebach in his work *Plantae Wrightianae e Cuba Orientali*, published in two parts from 1860-1862. Rarely did Wright publish his own finding, for it appears that he was much more interested in collecting than in writing.

Wright's return from Cuba in 1867 marked the end of his epic travels. In his later years he spent much time in Cambridge, working at the Gray Herbarium.

Locating the material was not easy because herbarium references were not always indicated. In other cases, neither the herbarium number nor the particular collection number is cited; therefore, thus it is difficult to know the precise origin of some specimens.

Another difficulty is that the material is sometimes poorly conserved or is very sparse and sometimes non-existent. Information on the specimen labels is generally incomplete or the collection date is illegible.

For this study, bibliographical references from specialized literature have been compiled and a taxonomic revision of the collections in the FH herbarium has been carried out.

Materials and Methods

The Cuban material we studied comes from the Harvard University, Farlow Herbarium (FH). Depending on their conservation state, they were studied macro- and microscopically.

Samples for light microscopy were mounted in Hoyer's medium and PVA according to Schnittler & Novozhilov (1996) and Koske & Tessier (1983). Spore measurements were made under an oil immersion objective and include surface structures such as spines or warts.

Scanning electron microscopy (SEM) images were prepared using the critical point method (Castillo et al. 1997) and the micrographs were produced at the University of Alcalá using a Zeiss DSM-950. This technique allows using very little material (one sporocarp, a part of it or only a small portion of spores).

In some cases, where the sample is scarce, is not well conserved or presents some taxonomic problem, it was compared with other Cuban material deposited in the Herbarium of the Cuba National Botanical Garden (HAJB).

In the list given below, we have used a question mark to indicate places where we had a problem in interpretation of data labels caused by such factors as faded handwriting and where localities seem no longer to exist. The beginning of data for each sample studied is indicated by "CUBA" in bold type.

The terminology used for the spore-producing stages follows Dörfelt & Marx (1990) and Lado & Pando (1997). The spore wall ornamentation as seen by SEM is described according to the terminology proposed by Rammeloo (1975a, b) and abbreviations for author citations follow Kirk & Ansell (1992).

Taxonomic Description

Arcyria cinerea (Bull.) Pers., Syn. Meth. Fung.: 184. 1801.

= *Arcyria albida* Pers., Neues Mag. Bot. 1: 90. 1794

= *A. bicolor* Berk. & M.A. Curtis in Berkeley, Grevillea 2: 67. 1873

SPECIMENS EXAMINED — **CUBA**: Retiro, on rotten wood, June 19, *leg.* C. Wright (672), Fungi Cubenses Wrightiani n° 542 (Gray Herbarium) FH, as *Arcyria bicolor* var. *albida*. **CUBA**: ad ram: deject, *leg.* C. Wright (672), ex folder 192, Curtis Fungus Herbarium n° 542, FH, as *Arcyria bicolor*.

COMMENTS — Berkeley (1869) mentions the collection “Wright 672” (Curtis Herbarium) as *Arcyria bicolor*, and Massee (1892) also mentions *A. bicolor* with the collection “Fung. Cub. Wrightian. 542” (Gray Herbarium). Both authors refer to the same collection (Wright 672) in two different herbaria: Gray Herbarium and Curtis Herbarium. The specimen from the Gray Herbarium has a hand-written label with the collection data and the substrate is “rotten wood”. However, in the material of the Curtis Herbarium appears: “ad ram: deject” and there is also another label written by Sturgis: “the digitate form of *A. cinerea*”.

Berkeley (1869) also cites *Arcyria cinerea* Fr. as “Wright 502”, but subsequently he says “With n° 502 is an abortive *Marasmius*”. Furthermore, *Arcyria cinerea* Fr. is a later homonym of *A. cinerea* (Bull.) Pers., according to Lado (2001).

Farr (1976) also refers to BPI material that has not been examined by us. There is also material of Wrightiani 542 in BM.

Arcyria denudata (L.) Wettst., Verh. Zool.-Bot. Ges. Wien 35: Abh. 535. 1886

= *Clathrus denudatus* L., Sp. Pl.: 1179. 1753

SPECIMENS EXAMINED — **CUBA ORIENTALI**: 1856-7, *leg.* C. Wright, Plantae Cubenses Wrightianae (Gray Herbarium) FH, as *A. incarnata*. **CUBA**: *leg.* C. Wright (801), ex folder 192, Curtis Fungus Herbarium, FH, as *A. punicea* Fr. **CUBA**: Cienfuegos, Botanical Woods, August 16-1933, *leg.* A. G. Kevorkian (30), *det.* G. D. Darke, FH. **CUBA**: rotten wood, April 1857, *leg.* C. Wright, Curtis folder 192, Curtis Fungus Herbarium, FH as *A. incarnata* Pers. **CUBA**: Santa Clara, San Blas, foothill of Trinidad Mountains, on dead “snag” 6 above ground, June 20-21-1941, *leg.* W.L. White (337), *det.* D.H. Linder, FH.

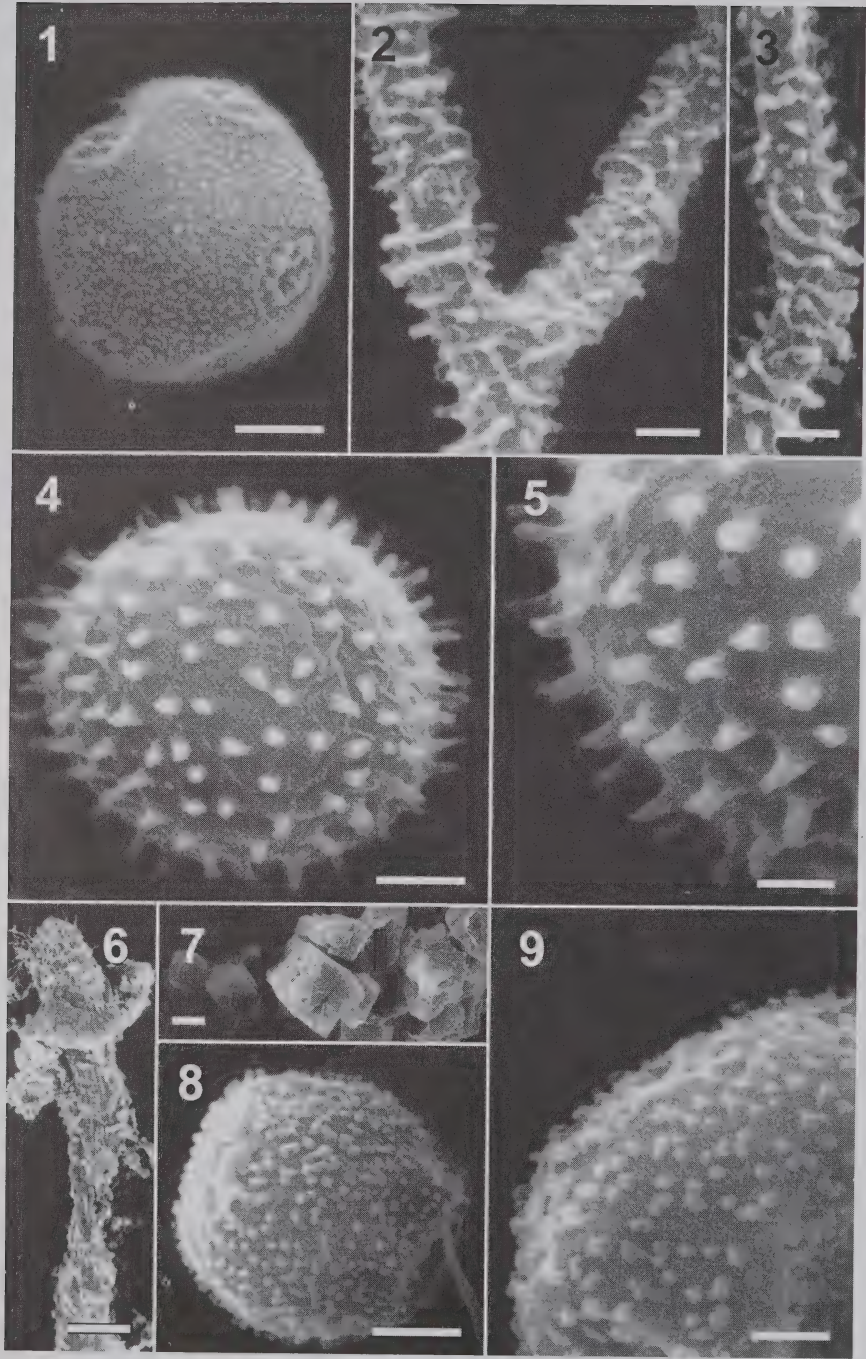
COMMENTS — There are two specimens identified as *Arcyria incarnata* Pers. and another as *A. punicea* Fr. but both correspond to *A. denudata* in agreement with the determinations made by Darke (Kevorkian 30) and Linder (White 337).

Arcyria magna Rex, Proc. Acad. Nat. Sci. Philadelphia 45: 364. 1893 **FIGURES 1-3**

SPECIMENS EXAMINED — **CUBA**: Baracoa, Maravi, 9-30-1910, FH, as *Arcyria incarnata*, revisado por M.L. Farr 7-XII-1972, *Arcyria oerstedtii*. *Ibidem*, FH, as *A. incarnata*.

COMMENTS — M.L. Farr determined this material (7-12-1972) as *Arcyria oerstedtii* Rost. and she mentions in *Flora Neotropica* (1976): “two specimens labelled *A. incarnata* from Baracoa, Cuba, 1910 (FH) have spinose capillitium and belong in *A. oerstedtii*.”

In this study we place both these specimens in *Arcyria magna* due to their pink



sporothecae which are drooping at maturity, with a lax capillitium that is extremely elastic, flaccid, deciduous and sculptured with cogs and half-rings and small spines.

Arcyria obvelata (Oeder) Onsberg, *Mycologia* 70 (6): 1286. 1979 ["1978"]

≡ *Embolus obvelatus* Oeder, *Fl. Dan.* 3(9): 8, tab. 536 (1770)

≡ *Arcyria nutans* (Bull.) Grev., *Fl. Edin.*: 455 (1824)

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7, *leg.* C. Wright, *Plantae Cubenses Wrightianae* n° 543 (Gray Herbarium) FH as *A. nutans* Grev. **CUBA:** April 1857, *leg.* C. Wright, Curtis 192, *Fungus Herbarium*, FH as *A. nutans* Grev.

COMMENTS — Farr (1976) comments on this species "the Cuban record is doubtful, since the apparent voucher collections (FH) no longer contains any myxomycete; however, this common species undoubtedly is present on the island".

The material examined of "Plantae Cubenses Wrightianae 543" and in "Curtis 192" it is not well conserved, and only capillitium was observed in the first, stalks and calyculus separated from the capillitium in later. The capillitium of samples studied exhibits pink tones. The lack of yellowish coloration makes us doubt the identity of these samples. However, this species is present in Cuba and is cited by Camino & Pérez (2000).

Berkeley (1869) mentions *Arcyria nutans* Fr. based on the collections of Wright 258, 262 (*Fungi Cubenses Wrightiani* 543). In the material received from FH, Wright's numbers do not appear but, as at least one refers to "*Fungi Cubenses Wrightiani* 543", we presume that it is the one mentioned by Berkeley (1869). Also, this species does not appear in Lado (2001) with Fries as the author.

Cribraria intricata Schrad., *Nov. Gen. Pl.*: 7. 1797

≡ *Trichia intricata* (Schrad.) Poir. in Lamarck, *Encycl.* 8: 56. 1808

SPECIMEN EXAMINED — **CUBA:** Santa Clara, Cienfuegos, Soledad, Blanco's Woods, July 1-1941, *leg.* W.L. White (581), *det.* D.H. Linder, FH.

COMMENTS — This species is mentioned for Cuba by Farr (1976) as FH without indication of the herbarium number. We examined the material of FH (White 581) and we agree with Linder's determination.

Diachea bulbillosa (Berk. & Broome) Lister in Penzig, *Myxomyc. Fl. Buitenzorg*: 45. 1898

FIGURES 4-7

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7, *leg.* C. Wright, *Plantae Cubenses Wrightianae* (Gray Herbarium) FH, as *D. elegans* Fr. **CUBA:** whitout locality, woods, Dec. 14, *leg.* C. Wright (665), *Fungi Cubenses Wrightiani* n° 537 (Gray Herbarium) FH, as *D. elegans* Fr. **CUBA:** ad Filicem, *leg.* C. Wright (665), ex folder

FIGURES 1-3. *Arcyria magna* (Baracoa, Maravi, 9-30-1910). 1. Spore (bar = 2 μ m). 2-3. Detail of capillitium (bar = 2 μ m). **FIGURES 4-7.** *Diachea bulbillosa* (C. Wright 665, *Fungi Cubenses Wrightiani* n° 537 as *D. elegans*). 4. Spore (bar = 2 μ m). 5. Detail of spore ornamentation (bar = 1 μ m). 6. Detail of columella (bar = 100 μ m). 7. Detail of cubical crystals of peridium (bar = 5 μ m). **FIGURES 8-9.** *Diderma effusum* (C. Wright 797, *Fungi Cubenses Wrightiani* 526 type as *Diderma cubense*). 8. Spore (bar = 2 μ m). 9. Detail of spore ornamentation (bar = 1 μ m).

187, Curtis Fungus Herbarium n° 537, FH, as *D. elegans* Fr., Rev. W.C.S. and M.L. Farr, 28-XI-1972, as *D. bulbillosa*.

COMMENTS — Of the six samples received and determined as *Diachea elegans*, after our revision, three specimens were considered to belong to *D. bulbillosa* and the other three to *D. leucopodia*.

Berkeley (1869) cites from the genus *Diachea* only *D. elegans* and mentions four specimens of Wright (268, 271, 495, 665), "Fungi Cubenses 537". Of these specimens we have been able to examine the samples Wright 268 and 665.

With the number Wright 665 (Fungi Cubenses 537) there are two exsiccatae, one of them placed inside an envelope and developed on fern fronds and another held inside a cardboard box, also on the same substrate. The latter was identified by W.C. Sturgis as *Diachea bulbillosa* and confirmed by Farr (28-XI-1972). We agree with these determinations. We think that the sample kept in the envelope is the original material because a hand-written note appears inside and the substrate is more abundant and complete. The other revised specimen of "Plantae Cubenses Wrightianae" has no number and the substrate appears to be grass.

By SEM, a short cylindrical columella with an obtuse apex is present. Spores are strongly spinose and the crystals of calcium carbonate are cubic.

***Diachea leucopodia* (Bull.) Rostaf., Sluzowce Monogr.: 190. 1874**

= *D. elegans* (Trentep.)Fr., Syst. Mycol. 3: 156. 1829

SPECIMENS EXAMINED — **CUBA:** sides of Loma del Gaso?, on grasses, *leg. C.* Wright (268), Fungi Cubenses Wrightiani n° 537 (Gray Herbarium) FH, as *D. elegans* Fr. **CUBA ORIENTALI:** 1856-7, *leg. C.* Wright, Plantae Cubenses Wrightianae (Gray Herbarium) FH, as *D. elegans* Fr. **CUBA:** on gram. & fol. dej., Jan. 1857, *leg. C.* Wright, ex folder 187, Curtis Fungus Herbarium n° 537, FH, as *D. elegans* Fr.

COMMENTS — Farr (1976) questions the presence of *D. leucopodia* in Cuba, as although originally the Cuban specimens were determined as *D. elegans*, synonym of *D. leucopodia*, some specimens of FH are indeterminate and another, (Wright 665), belongs to *D. bulbillosa*.

The material "Wright 228" (Fungi Cubenses Wrightiani 537), is mentioned by Berkeley (1869) and the other two specimens do not bear numbers. In one of them, there appears on the border the hand-written note "Curtis 187", and we suppose that this belongs to Curtis Fungus Herbarium.

We confirmed that *Diachea leucopodia* is cited for Cuba by Berkeley (1869) and Massee (1892). This species has been mentioned later by Camino & Perez (2001).

***Diderma effusum* (Schwein.) Morgan, J. Cincinnati Soc. Nat. Hist. 16: 155. 1894**

FIGURES 8-9

= *D. cubense* Berk. & M.A. Curtis in Berkeley, J. Linn. Soc. Bot. 10: 347. 1868

SPECIMENS EXAMINED — **CUBA:** on leaves? among coffee plants, July, *leg. C.* Wright (797), Fungi Cubenses Wrightiani 526 Gray Herbarium, FH type as *Diderma cubense*. **CUBA:** ad fol. mort, July, *leg. C.* Wright (797), ex folder 177, No. 526, Curtis Fungus Herbarium, FH as *Diderma cubense*.

COMMENTS — The first sample is kept inside a paper envelope with a red label that

indicates "TYPE". Inside this are numerous pieces of leaves and some stems that are fragmented. We have been able to separate two pieces of leaves with at least one complete sporocarp and other open ones that have been deposited in an Eppendorf tube for their protection. We have been able to observe remains of spores.

The sporocarps are whitish, sessile, with a marked line of dehiscence, the columella is pale ochraceous to ochraceous whitish and flat. The spores are globose, pale violaceous, (5-)6-8(-9) μm in diam, warted, with groups of darker, more prominent warts. The capillitium has not been observed in order to conserve the complete sporocarp. Spore ornamentation by SEM consists of small, irregularly distributed baculae.

In the second sample (a duplicate of the first) the material is kept in a cardboard box but only the hypothallus, some pseudocolumellae and a few spores are conserved. It was revised by M.L. Farr (28-XI-1972) who indicates that "This is the type of *Diderma cubense* B & C, which is listed by Martin & Alexopoulos (1969), as syn. of *D. testaceum*. We would prefer to place this specimen in *D. effusum* (Schw.) Morgan".

After studying the type material of *Diderma cubense*, we agree with Farr (1976) that it is a synonym of *D. effusum* and not of *D. testaceum* (Schrad.) Pers., as Martin & Alexopoulos (1969) had indicated.

Didymium squamulosum (Alb. & Schwein.) Fr., Symb. Gasteromyc.: 19. 1818

= *D. costatum* Fr., Syst. Mycol. 3: 118. 1829

= *D. herbarum* Fr., Syst. Mycol. 3: 120. 1829

SPECIMENS EXAMINED — **CUBA:** Stalks & leaves of Congo Bean, Jan. 1857, *leg.* C. Wright, ex folder 179, Curtis Fungus Herbarium, FH as *Didymium herbarum* Fr. **CUBA:** ad folia deject, *leg.* C. Wright (667), ex folder 179, n° 527 Curtis Fungus Herbarium, FH as *Didymium costatum* Fr. **CUBA:** *leg.* C. Wright, Fungi Cubenses Wrightiani n° 527 (Gray Herbarium) FH as *Didymium costatum* Fr.

COMMENTS — In the sample originally identified as *Didymium herbarum*, there is a hand-written label that says "*D. squamulosum*" but without any signature. This sample consists only of one complete, loose sporocarp. In the sample "Wright 667", one typical stalk, one sporocarp and very few spores are conserved. The sample without number of Wright (Fungi Cubenses Wrightiani n° 527) consists of several complete sporocarps that are typical for this species.

Berkeley (1869) mentions *Didymium costatum* as "Wright 667" (Fungi Cubenses Wrightiani 527), growing on a leaf. We examined two specimens with this number but one has no indication of Wright's collection number. However, it is very evident that it belongs to the same collection (Wright 667) because it is clear that the leaf was cut to make a duplicate. We confirm the presence of *D. squamulosum* in Cuba.

Massee (1892) also mentions *Didymium squamulosum* but he does not indicate exsiccatae.

Fuligo septica (L.) F.H. Wigg., Prim. Fl. Holsat.: 112. 1780

= *Aethalium septicum* (L.) Fr., Syst. Mycol. 3: 93. 1829

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7, *leg.* C. Wright, Plantae Cubenses Wrightianae (Gray Herbarium) FH, as *Aethalium septicum*. **CUBA:** Monte Verde, on rotten wood in field, *leg.* C. Wright, Plantae Cubenses Wrightianae n° 525,

FH, as *Aethalium septicum*. **CUBA:** Cienfuegos, Soledad, growing on trash heap at edge of cane field on road to Limonos, Sept. 12-1933, leg. A. G. Kevorkian (51), det. G. D. Darke, FH.

COMMENTS — Wright 525 is the only sample recorded by Berkeley (1869).

Massee (1892) also mentions *Fuligo septica* as *Fuligo varians* Rostaf., but does not indicate exsiccatae.

Hemitrichia calyculata (Speg.) M.L. Farr, Mycologia 66 (5): 887. 1974

FIGURES 10-12

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7, leg. C. Wright, Plantae Cubenses Wrightiani n° 547 (Gray Herbarium) FH, as *Trichia serotina*.

COMMENTS — Berkeley (1869) mentions *Trichia clavata* Pers. as collection “Wright 259”. It is probable that the material we revised coincides with that mentioned by Berkeley (1869), because the label bears the epithet “*clavata*” together with the number “547” (Plantae Cubenses Wrightianae). This number coincides with the reference of Fungi Cubensis Wrightianae in Berkeley (1869).

Massee (1892) reported *Arcyria clavata* without indicating exsiccatae. Farr (1976) indicates: “this species appears to be confined to temperate habitats; collections reported from tropical areas generally prove, upon reexamination, to be *Hemitrichia calyculata*”. We suppose that this might be the case with records from Cuba and we can confirm this thesis with numerous Cuban specimens in the herbarium (HAJB) collected more recently.

By SEM the peridium has small irregular crests, the capillitium has spiral bands with very small warts on the outside and spores are reticulate with meshes of varying diameters.

Hemitrichia serpula (Scop.) Rostaf. ex Lister, Monogr. Mycetozoa: 179. 1894

≡ *Mucor serpula* Scop., Fl. Carniol., ed. 2, 2: 493. 1772

≡ *Trichia serpula* (Scop.) Pers., Neues Mag. Bot. 1: 90. 1794

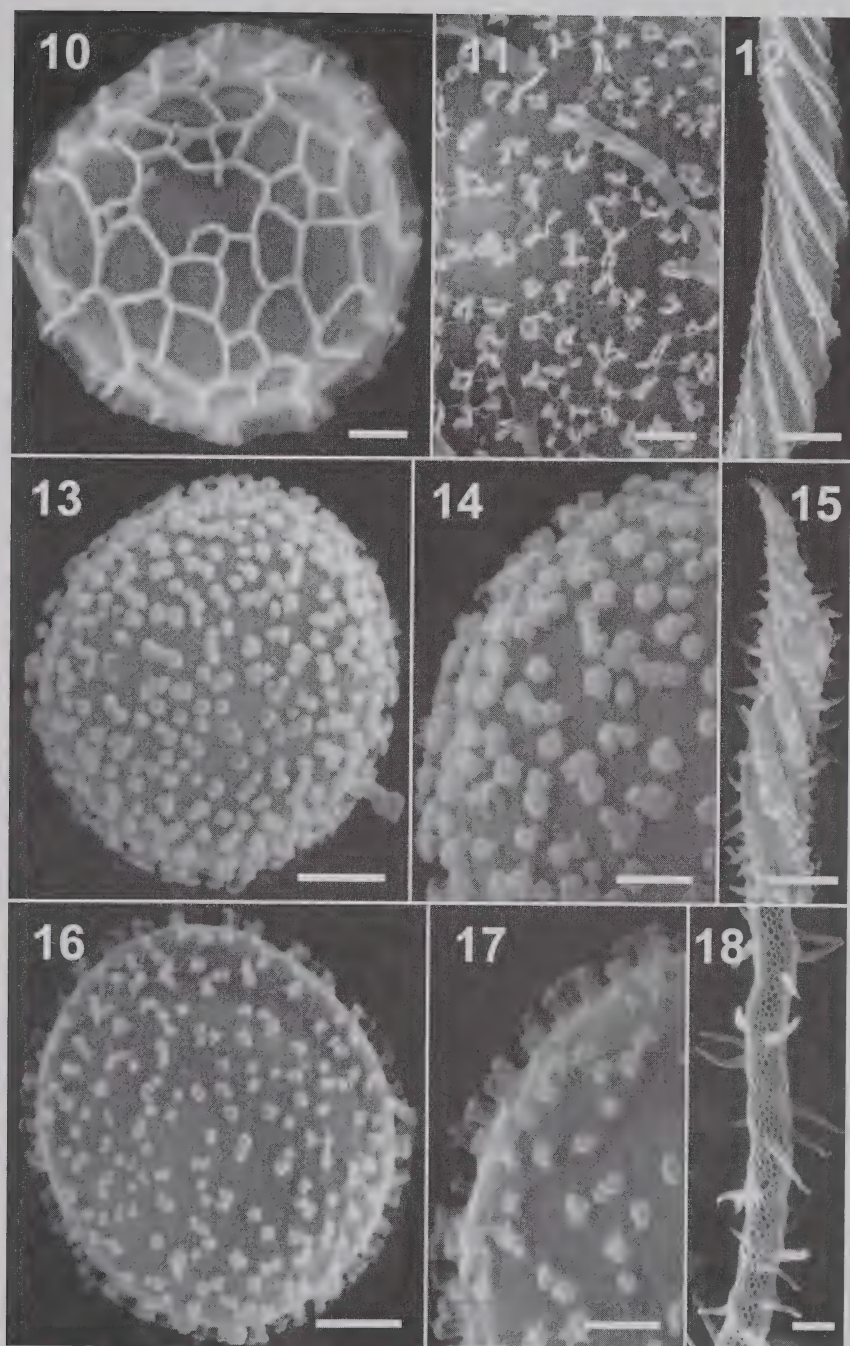
≡ *Arcyria serpula* (Scop.) Massee, Monogr. Myxogastr.: 164. 1892

SPECIMENS EXAMINED — **CUBA:** on logs, 1857, leg. C. Wright (265), ex folder 193, n° 550 Curtis Fungus Herbarium, FH, as *Trichia serpula*. **CUBA:** Cienfuegos, Soledad, Government Road near Bot. Wood, August 25-1933, leg. A. G. Kevorkian (45), det. G. D. Darke, FH.

COMMENTS — The collection Wright 265 is mentioned by Berkeley (1869) as *Trichia serpula* Pers. In the border of the label there is a note: “to 260 similar, but threads hisfrid?” (see observations of *Trichia persimilis*).

In the other material we agree with the determination of Darker (Kevorkian 45).

FIGURES 10-12. *Hemitrichia calyculata* (Plantae Cubenses Wrightiani n° 547 as *Trichia serotina*). 10. Spore (bar = 2 μ m). 11. Inner side of peridium (bar = 2 μ m). 12. Detail of capillitium (bar = 5 μ m). **FIGURES 13-15. *Metatrachia horrida*** (1856-7 C. Wright, Fungi Cubenses Wrightiani as *Trichia rubiformis*). 13. Spore (bar = 2 μ m). 14. Detail of spore ornamentation (bar = 1 μ m). 15. Detail of capillitium (bar = 5 μ m). **FIGURES 16-18. *Perichaena chrysosperma*** (C. Wright 673, type as *Ophiotheca wightii* Berk. & M.A. Curtis). 16. Spore (bar = 2 μ m). 17. Detail of spore ornamentation (bar = 1 μ m). 18. Detail of capillitium (bar = 2 μ m).



Massee (1892) mentions *Arcyria serpula*, but he does not indicate exsiccatae.

Hemitrichia parviverrucospora (Lizárraga, G. Moreno & Illana) G. Moreno & Illana is a closely related species that shares the same macroscopy but which possesses a capillitium with a very spiny ornamentation, with spines frequently 4-7 μm long, reticulate spores with small warts within the meshes which are visible only by SEM. Up to the present time, this species has been recorded only from Central Africa and Mexico (Baja California Sur and Sinaloa) according to Pérez-Silva et al. (2001).

***Lycogala epidendrum* (L.) Fr., Syst. Mycol. 3: 80. 1829**

SPECIMENS EXAMINED — **CUBA:** *leg.* C. Wright (882, 911), ex folder 173, Curtis Fungus Herbarium No. 520, FH.

COMMENTS — This species is one of the first six records of Myxomycetes from Cuba by Montagne (1845) (material not seen).

It is also mentioned by Berkeley (1869) as collection “Wright 316” (Fungi Cubenses Wrightiani n° 520). In the material we received (Wright 882 and 911) appears hand written on the label the number “520”, which does not coincide with the original reference of Berkeley (1869).

The number 882 of Wright’s collection was collected from wood and the number 911 had developed on bryophytes.

Massee (1892) also mentions *Lycogala epidendrum* but no exsiccatae were indicated.

***Metatrichia horrida* Ing, Trans. Brit. Mycol. Soc. 47 (1): 51. 1964** **FIGURES 13-15**

SPECIMENS EXAMINED — **CUBA:** rotten wood, Jan. 1857, *leg.* C. Wright, ex folder 193, Curtis Fungus Herbarium, FH, as *Trichia rubiformis* Pers. **CUBA:** lign. carios?, *leg.* C. Wright 681, ex folder 193, n° 545 Curtis Fungus Herbarium, FH. **CUBA:** *leg.* C. Wright, Fungi Cubenses Wrightiani n° 555 (Gray Herbarium) FH, as *Trichia rubiformis*. **CUBA ORIENTALI:** 1856-7, *leg.* C. Wright, Fungi Cubenses Wrightiani (Gray Herbarium) FH, as *Trichia rubiformis*.

COMMENTS — The four revised specimens were identified as *Trichia rubiformis* and one of these (Wright 681) is mentioned by Berkeley (1869).

Until very recently, the identification of Cuban specimens as *Metatrichia vesparium* has been erroneous. The present species in the tropics is *M. horrida* and it is characterized mainly by the group of threads in hair-spring disposition when the peridium opens and the strongly spinulose capillitium (Moreno et al. 1997), that we confirm in tropical and temperate specimens from HAJB and AH herbarium.

Metatrichia horrida was described originally from Nigeria (Africa) by Ing (1964) and later it was found in several African countries. The first references of this species for the American continent are from Baja California (Mexico) and their differences from *M. vesparium* has been discussed thoroughly by Moreno et al. (1997).

***Mucilago crustacea* F.H. Wigg., Prim. Fl. Holsat.: 112. 1780**

SPECIMENS EXAMINED — **CUBA:** Mina Carlota, Sierra de San Juan, Trinidad Mountains, on log, July 1-1941, *leg.* W.L. White (758), *det.* D.H. Linder, FH, as *Fuligo septica* var. *candida*.

COMMENTS — A new record for Cuba. This cosmopolitan species occurs in Neotropical latitudes Farr (1976).

Perichaena chrysosperma (Curr.) Lister, Monogr. Mycetoza 196. 1894

FIGURES 16-18

= *Ophiotheca wrightii* Berk. & M.A. Curtis in Berkeley, J. Linn. Soc, Bot. 10: 349 (1868)

ORIGINAL DIAGNOSIS — *Ophiotheca wrightii*: Peridio annulari firmo badio; floccis aculeatis; sporis luteis subangularibus (673).

SPECIMENS EXAMINED — **CUBA**: dead wood, leg. C. Wright (673), ex folder 185, Curtis Fungus Herbarium n° 544, FH, as *Ophiotheca wrightii* Berk. & M.A. Curtis. **CUBA**: leg. C. Wright (673), Gray Herbarium, FH, type as *Ophiotheca wrightii* Berk. & M.A. Curtis.

COMMENTS — The material is well preserved, mainly the labelled one to be regarded as the typus, and considering the second as the isotype, both with abundant well-developed sporocarps. Macroscopic and microscopic features agree with *Perichaena chrysosperma* and by SEM we observed globose spores of 10-11 μm in diam., with a sparse irregular ornamentation formed by pila. The capillitium has abundant long thorns and the surface has numerous perforations of different diameters, resembling a sponge (Fig. 18). For this reason, we think that *Ophiotheca wrightii* is synonymous with *P. chrysosperma* which was studied by SEM of material from Baja California (México) by Lizárraga et al. (1999), agreeing totally with Cuban material.

Massee (1892) describes *Ophiotheca wrightii*, and indicates that the type is deposited in Kew herbarium (K 10888). Rammeloo (1984) also studied part of the type material kept in Kew (Wright, 673) and which agrees with our observations: Nevertheless, this author did not incorporate SEM images of sporal ornamentation.

Physarella oblonga (Berk. & M.A. Curtis) Morgan, J. Cincinnati Soc. Nat. Hist. 19: 7. 1896

SPECIMENS EXAMINED — **CUBA**: Cienfuegos, Soledad, on decayed *Ceiba pentandra*, Sept. 12-1933, leg. A.G. Kevorkian (59), det. G. D. Darke, FH.

COMMENTS — The material consists of opened sporocarps with typical orange fusiform nodules. This species is mentioned for Cuba by Farr (1976) of FH without indicating exsiccatae. We examined the material of FH (Kevorkian 59) and we agree with Darke's determination.

Physarum cinereum (Batsch) Pers., Neues Mag. Bot. 1: 89. 1794

= *Didymium cinereum* (Batsch.) Fr., Syst. Mycol. 3:126. 1829

SPECIMENS EXAMINED — **CUBA**: Cienfuegos, on lawn in yard of Harvard House, Sept. 4-1933, leg. A. G. Kevorkian (50), det. F.L. Howard, FH.

COMMENTS — The sample "Kevorkian" (50) is in good conditions, very abundant, well-developed and displays the typical characters of this species. We agree with the determination by F.L. Howard.

In the sample "Wright 679" the number appears to be written by hand, beside a not very readable note "M.V. Ap. 27 spreading over leaves chip & coffee chaff". This specimen is cited by Berkeley (1869) as *Didymium cinereum*.

Massee (1892) cited *Physarum cinereum* (Fungi Cubenses Wrightiani, 535).

Physarum compressum Alb. & Schwein., Consp. Fung. Lusat.: 97. 1805

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7, leg. C. Wright (42), Plantae Cubenses Wrightianae (Gray Herbarium) General Fungi Herb. 42. FH. as *Didymium sp.* rev M.L. Farr (30-XI-1972) as *Physarum compressum*. **CUBA:** leg. C. Wright (907), ex folder 179, Curtis Fungus Herbarium, FH as *Didymium furfuraceum*, rev. M.L. Farr (28-XI-1972) as *Physarum compressum*. **CUBA:** Rangel, on sticks & leaves, June 10, leg. C. Wright (907) FH as *Physarum polycephalum* Schw. var. *obrusseum* (B. & C.)

COMMENTS — The specimen "Wright 907" is kept in a round cardboard box and several complete sporocarps are present. The box lid bears a hand-written note: "exceptionally calcareous lime white". This sample represents *Physarum compressum*.

We agree with Farr's determination (30-XI-1972) of the specimen "Wright 42" and the comment that she makes in the label "unidentifiable (only stipes left) perhaps *Physarum compressum* Alb. & Schw". It is impossible to make a good study of the material because the few sporotheca are imperfectly developed, although their compressed form and stout stipes maintain their characteristics, being furrowed, cylindrical or tapered near the union with the sporotheca, dark brown mostly toward the base and coated with white lime toward the apex. These characters indicate that the material corresponds with *Physarum compressum*.

Two other specimens appear with the same collection number (Wright 907) but with different identifications. One of these as *Didymium furfuraceum* without locality and substrate information. We agree with Farr (28-XI-1972) who identified this material "as probably *Physarum compressum*". The other material is named *Physarum polycephalum* Schw. var. *obrusseum* and on the cover of the box is written "exceptionally calcareous, lime white"; a hand-written note inside the box gives number, locality data and type of substrate. This collection (Wright 907) is referred to neither in Berkeley (1869) nor Massee (1892).

Physarum didermoides (Pers.) Rostaf., Sluzowce Monogr.: 97. 1874

SPECIMENS EXAMINED — **CUBA:** leg. Guba, det. F.L. Howard. FH. **CUBA:** Baracoa, on leaves, leg. Mm. Roren?, April-1904, FH.

COMMENTS — The sample determined by Howard is conserved in a cardboard box and although it is very broken and some sporocarps are sclerotized, the whitish hypothallus, elongated, cylindrical sporocarps with a double peridium and a whitish stipe can be observed. The spores are spinulose, dark and polygonal, 12-14 μm in diam.

The specimen from Baracoa is also conserved in a cardboard box, with typical, abundant and well fructified sporocarps.

Physarum didermoides is mentioned for Cuba by Farr (1976) in FH without indicating exsiccatae. We examined two specimens from this herbarium and we agree with the determination of *P. didermoides*.

Physarum licheniforme (Schwein.) Lado, Nomenmyx 16: 70. 2001

= *Physarum lividum* Rostaf., Sluzowce Monogr.: 95. 1874

= *Physarum didermoides* var. *lividum* (Rostaf.) Lister, J. Bot. 36: 161. 1898

SPECIMENS EXAMINED — **CUBA**: spreading over leaves chips & coffee chaff, *leg.* C. Wright (679), Fungi Cubenses Wrightiani n° 535 (Gray Herbarium) FH as *Didymium cinereum*.

COMMENTS — The specimen “Wright 679” is well conserved and it contains groups of subglobose, pyriform and cylindrical sporocarps. Frequently short, white-cinereous plasmodiocarps forming extensive groups, without stipes, bearing a single peridium with few calcium carbonate deposits are observed. The capillitium is formed by large, white, angular to elongated nodes, with badhamioid appearance, but always with hyaline filaments; nodes sometimes fused in the centre to form a pseudocolumella. Spores 12-14 μ m in diam., homogeneously spinulose, brown violaceous by the light microscope.

We consider *Physarum lividum* to be an independent species, different from *P. didermoides*, characterized by sessile and globose sporocarps with a single peridium with few calcium carbonate, agreeing with Nannenga-Bremekamp (1974).

We have examined the material “Wright 679” (Fungi Cubenses Wrightiani n° 535) indicated by Berkeley (1869) as *Didymium cinereum* Fr. and verified that it corresponds with *Physarum licheniforme*. With the number “Wright 679” there are two specimens and they probably correspond with the Curtis and Gray Herbarium respectively. We suppose that material from the Gray Herbarium is the original one, due to the hand written text giving more information than the other specimen.

Physarum polycephalum Schwein., Schriften Naturf. Ges. Leipzig 1: 63. 1822

= *Didymium obrusseum* Berk. & M.A. Curtis in Berkeley, J. Linn. Soc. Bot. 10: 348. 1868

= *Physarum obrusseum* (Berk. & M.A. Curtis) Rostaf., Sluzowce Monogr. Suppl.: 11. 1876

= *Physarum polycephalum* var. *obrusseum* (Berk. & M.A. Curtis) Lister, Monogr. Mycetozoa: 48. 1894

= *Physarum polymorphum* Mont., Ann. Sci. Nat. Bot. sér. 2, 8: 361. 1837

= *Didymium tenerrimum* Berk. & M.A. Curtis in Berkeley, J. Linn. Soc. Bot. 10: 348. 1868

SPECIMENS EXAMINED — **CUBA**: fol. *Tillandsia*, June 1857, *leg.* C. Wright (267), ex folder 179, n° 533, Curtis Fungus Herbarium, FH as “*Didymium tenerrimum* B. & C.”. A large envelope as “*Didymium sp.*” with three samples, two of them: **CUBA ORIENTALI**: 1856-7, *leg.* C. Wright (41), Plantae Cubenses Wrightianae (Gray Herbarium) FH, rev. M.L. Farr 30-XI-1972 as *Physarum polycephalum* and **CUBA ORIENTALI**: 1856-7, *leg.* C. Wright (44), Plantae Cubenses Wrightianae (Gray Herbarium) FH, rev. M.L. Farr 30-XI-1972 as *Physarum polycephalum*. **CUBA**: on rotten wood, Mar 29, *leg.* C. Wright (664), Fungi Cubenses Wrightiani n° 532 (Gray Herbarium) FH. as *Didymium obrusseum*. **CUBA**: ad folia, *leg.* C. Wright (799), ex folder 179, n° 532 Curtis Fungus Herbarium, FH. as “*Didymium obrusseum* B. & C.”. **CUBA**: Retiro, on dead leaves & sticks in woods, Dec. 4, *leg.* C. Wright (868), Fungi Cubenses Wrightiani FH. as “*Physarum polycephalum* Schw. var. *obrusseum*

(B. & C.)". **CUBA:** *leg. C. Wright* (532), *Fungi Cubenses Wrightiani* n° 539 FH. as "*Didymium obruseum* B. & C." but inside the lid of the box also appears "*Physarum polymorphum*", **CUBA:** *Wright*. 532, see *Lister's* letter of Mar. 1893", and inside the box "*Didymium obruseum*, *Fungi Cubenses Wrightiani* n° 539". **CUBA:** on trunk: *dej:* corrupt, *leg. C. Wright* (868, 919), ex folder 182, *Curtis Fungus Herbarium*, FH. as *Physarum utriculare* Fr.

COMMENTS — The Cuban specimens are mostly conserved in envelopes. For this reason, they contain crushed, flattened sporocarps and the (more or less discoid) sporotheca are broken. We are able to observe only parts of the whitish membranous peridium, sparse whitish capillitial nodes and a brown violaceous spore-mass. The stipes are yellow, straw-coloured, translucent, wider at the base, flattened, without remains of calcium carbonate, with an abundant growth which is sometimes caespitose.

The presence of solitary sporothecae characterizes *Physarum polycephalum* var. *obrusseum* that very frequently fructifies in the tropics. However, this character has been demonstrated to have no taxonomic value (Alexopoulos 1969), a conclusion that we also support.

Physarum polycephalum macroscopically resembles *P. pezizoideum* (Jungh.) Pavill. & Lagarde, as Farr (1976) suggests, but the latter species differs by its more pronounced spore ornamentation and its stipe morphology.

The specimen "Wright 532" is conserved in a cardboard box, and on the lid of which is written "*Physarum polymorphum* see *Lister's* letter of Mar. 1893" and a label inside "*Didymium obruseum*". These species are considered to be synonyms of *P. polycephalum* (Lado, 2001).

This species has been frequently cited from Cuba with other epithets. The first record was made by Montagne (1845) as *Didymium polymorphum* (material not seen). This species was also referred by Berkeley (1869) and Massee (1892) as "*Fungi Cubenses Wrightiani* n° 532" (Wright 664 y 799) as "*Didymium obruseum* B. & C." and it was mentioned as "*D. tenerrimum* B. & C." by Berkeley (1869) of the collection "Wright 267" and by Massee (1892) without exsiccatae and he says "... no specimen exists in Berkeley's Herbarium..."

Lister (1894) reported this species as *Physarum polymorphum* (Cuba, BM 440) on the label of which appears "Cuba, *leg. C. Wright* n° 532". It therefore corresponds with "*Fungi Cubenses Wrightiani* n° 532", Wright's collections 664 and 799. We examined specimens bearing this number deposited in FH and determined them as *Physarum polycephalum*.

Stemonaria longa (Peck) Nann.-Bremek., R. Sharma & Y. Yamam., in Nannenga-Bremekamp, Yamamoto & Sharma, *Proc. Kon. Ned. Akad. Wetensch.*, C 87 (4): 453; 1984

= *Comatricha longa* Peck, *Annual Rep. New York State Mus.* 43: 70. 1890

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7, *leg. C. Wright*, *Plantae Cubenses Wrightianae* (Gray Herbarium) FH, as *Stemonitis fusca*.

COMMENTS — Camino et al. (2003) indicates: "This species was reported for Cuba by Lister (1894) as *Comatricha longa*, based on a specimen that was deposited in Kew Herbarium (K. 1606, C. Wright 261). We studied this material, which corresponds with

Stemonitis splendens. For this reason, the record by Camino (1998) represents the first record of *Stemonaria longa* for Cuba". It is clear that the number "Wright 261 (K)" mentioned by Berkeley (1869) as *Stemonitis fusca* and by Lister (1894) as *Comatricha longa* corresponds with *Stemonitis splendens*. However, when examining the material "Wright s/n" (Plantae Cubenses Wrightianae) which was erroneously identified as *Stemonitis fusca* Roth, we find that it corresponds with *Stemonaria longa*. Thus, this material is the first collection of this species in Cuba, although it does not appear as such in previous papers.

Stemonitis fusca Roth, Bot. Mag. (Römer & Usteri) 1 (2): 26. 1787

SPECIMENS EXAMINED — **CUBA:** without locality, ad cortices *leg.* C. Wight (668), ex folder 188, n° 539, Curtis Fungus Herbarium, as *S. ferruginea*. **CUBA:** without locality, *leg.* C. Wright (667), Fungi Cubenses Wrightiani n° 539 (Gray Herbarium) FH, as *S. ferruginea*. **CUBA ORIENTALI:** 1856-7, *leg.* C. Wright, Plantae Cubenses Wrightianae (Gray Herbarium) FH, as *S. typhoides*. **CUBA:** without locality, on logs, 1857, *leg.* C. Wight, ex folder 188, n° 540?, Curtis Fungus Herbarium, as *S. typhoides*, rev. M.L. Farr, 28-XI-1972, "not as determined; very moldy, but probably *S. fusca*; spores verr.-reticulate". **CUBA:** Cienfuegos, Seboruco, Botanical Wood, on dead wood, 17-VIII-1933, *leg.* A.G. Kevorkian (35), *det.* G. D. Darke, FH.

COMMENTS — The revision of the material "Wright 668", mentioned by Berkeley as *Stemonitis ferruginea* belongs to *S. fusca* and we agree with the determination made by Sturgis and Farr (28-XI-1972). We also agree with Farr (28-XI-1972) and Darke in the identification of the material "Wright s/n" (Curtis 540 ex folder 188) and (Kevorkian 35) respectively.

The identification of the specimen "Wright 667" (Fungi Cubenses Wrightiani n° 539) as *Stemonitis ferruginea* is erroneous and it belongs to *S. fusca*.

The material of the collection "Wright (s/n)" identified as *Stemonitis typhoides* (Plantae Cubenses Wrightianae) is contaminated with fungi and it appears covered with white filaments that may have caused its incorrect identification.

Stemonitis splendens Rostaf., Sluzowce Monogr.: 195. 1874

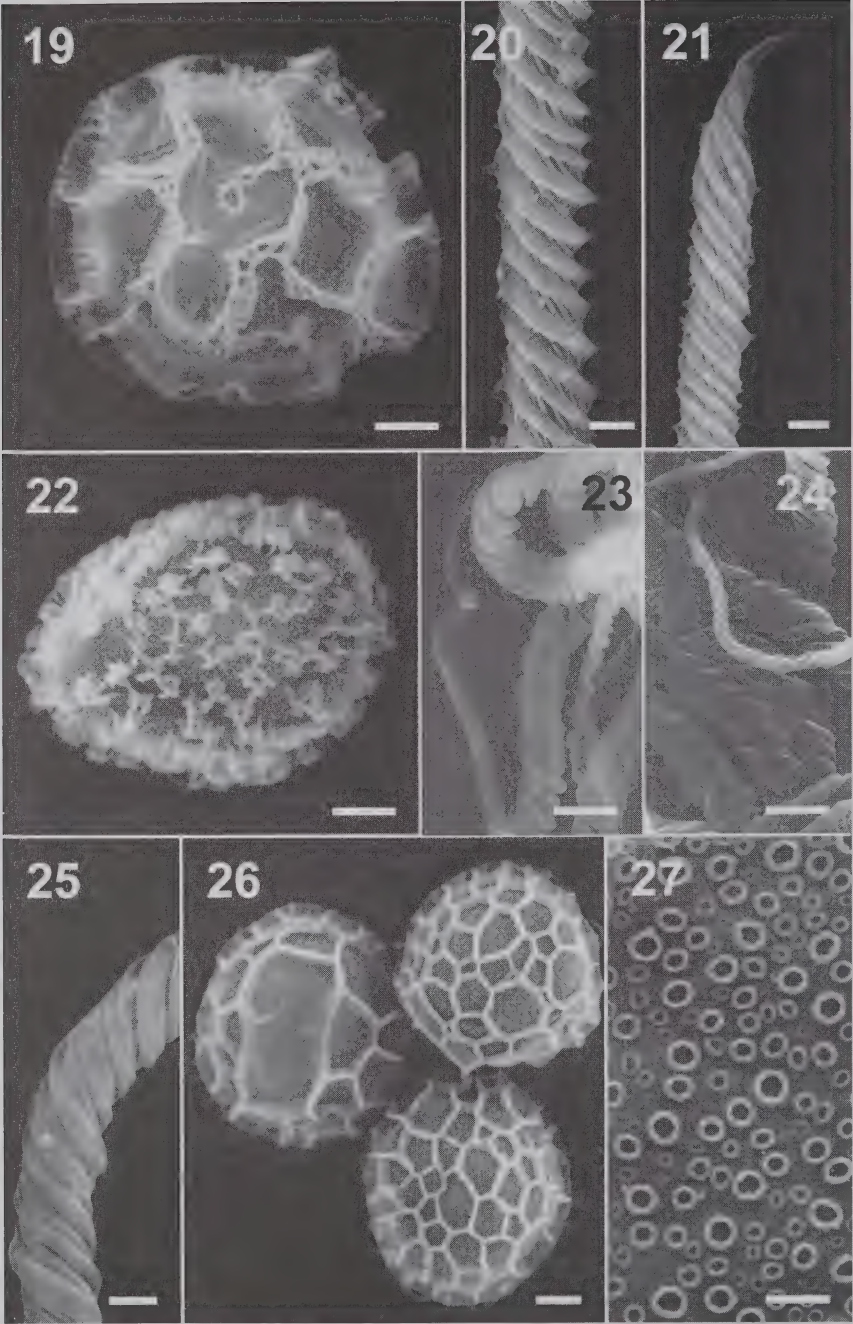
SPECIMENS EXAMINED — **CUBA:** in truck of twigs? in wood, April 9, *leg.* C. Wright (671), Fungi Cubenses Wrightiani n° 538, (Gray Herbarium) FH, as *S. fusca*, rev. M.L. Farr, 28-XI-1972 as *S. splendens*; **CUBA:** ad cortices, *leg.* C. Wright (671), ex folder 188, n° 538 Curtis Fungus Herbarium, FH. as *S. fusca*, rev. M.L. Farr, 28-XI-1972 as *S. splendens*.

COMMENTS — Both of the specimens we examined correspond with "Wright 671" (Fungi Cubenses Wrightiani 538), previously mentioned by Camino et al. (2003) and originally cited as *Stemonitis fusca*. We agree with the revision of M.L. Farr (28-XI-1972).

Trichia affinis de Bary in Fuckel, Jahrb. Nassauischen Vereins Naturk. 23-24: 336. 1870

FIGURES 19-22

SPECIMENS EXAMINED — **CUBA ORIENTALI:** 1856-7 *leg.* C. Wright, Plantae Cubenses Wrightianae (Gray Herbarium) FH. **CUBA ORIENTALI:** 1856-7, *leg.* C.



Wright, Plantae Cubenses Wrightianae (Gray Herbarium) FH. CUBA: on logs, 1857, leg. C. Wright (260), ex folder 193, n° 549 Curtis Fungus Herbarium, FH, as *Trichia turbinata* With.

COMMENTS — In one of the studied specimens that appear with the same typography, the epithet “*persimilis*”, the reviewer’s initials (W.C.S.) and the date (XII.13.13) was recorded. Comparing this typography with that of other labels, this determination was made by W.C. Sturgis which we were able to confirm.

Farr (1976) considered *Trichia persimilis* and *T. affinis* de Bary to be synonyms of *T. favoginea* (Batsch) Pers. Farr (1958) cites Cuba material of *T. favoginea* from BPI, FH and Masee (1892).

According to our experience, the diameter of the capillitium is a good character to separate *Trichia favoginea* (8-10 μm) from *T. affinis* and *T. persimilis* (4-6 μm). However, the separation of these latter two species is not so easy. The presence of a capillitium with smooth spiral bands and spores with a broken reticulum characterizes *T. affinis* and the presence of a capillitium with spiny spiral bands and spores with a reticulum in the form of islets or patches of reticulum is typical of *T. persimilis*. In the case of the Cuban specimens kept in FH, they all present a capillitium with spiny spiral bands and spores with a broken reticulum. Thus, the capillitium is from *T. persimilis* and the spores match those of *T. affinis*. We give preference to the spore ornamentation and determined these specimens as *T. affinis* (Fig. 19).

The typical sporal ornamentation of *Trichia persimilis* has recently been studied in material from Mexico (Chihuahua) by Lizarraga et. al. (2003).

When revising the collection “Wright 260” mentioned by Berkeley (1869) as *Trichia turbinata*, following the concept of the authors, it corresponds with *T. affinis* and it presents a capillitium with very small spines and spores with incomplete reticulum.

Trichia decipiens* var. *olivacea (Meyl.) Meyl., Bull. Soc. Vaud. Sci. Nat. 55: 244. 1924

FIGURES 22-24

≡ *Arcyria decipiens* Pers., Ann. Bot. (Usteri) 15: 35. 1795

= *Trichia fallax* Pers., Observ. Mycol. 1: 59. 1796

SPECIMENS EXAMINED — CUBA: on logs, 1857, leg. C. Wright, ex folder 193, n° 546 Curtis Fungus Herbarium, FH, as *T. varia*.

COMMENTS — The material was originally identified as *Trichia varia*, but was subsequently revised by M.L. Farr (28-XI-1972) and re-identified as *T. verrucosa* with the note “see slide”. We disagree with M.L. Farr’s determination because when examining the material, the threads of the capillitium were found to bear very elongated ends and the spores are 11-13 μm in diam. and have a crested ornamentation. These

FIGURES 19-21. *Trichia affinis* (n° 549 Curtis Fungus Herbarium, as *Trichia turbinata*). 19. Spore (bar = 2 μm). 20. Detail of capillitium (bar = 2 μm). 21. Detail of termination of capillitium (bar = 2.5 μm). **FIGURES 22-24.** *Trichia decipiens* var. *olivacea* (n° 546 Curtis Fungus Herbarium, as *T. varia*). 22. Spore (bar = 2 μm). 23. Detail of capillitium (bar = 5 μm). 24. Detail of capillitium (bar = 2.5 μm). **FIGURES 25-26.** *Tubulifera microsperma* (Fung. Cub. 551, as *Licea stipitata*). 25. Spores (bar = 1 μm). 26. Inner side of peridium (bar = 2 μm).

features match those of *T. decipiens* var. *olivacea*. Although the olivaceous colour of the sporotheca is not so evident, the spore ornamentation and capillitium that characterizes this variety are present.

In another envelope, the slide with M.L. Farr's label reading *Trichia verrucosa* appears to match that of *Trichia affinis* due to the spore ornamentation with a broken reticulum, az capillitium that is is smooth or has very short spines (visible only in oil immersion), and elaters with short free ends (Figs. 23-24). But this slide does not correspond (possibly by mistake) with the present sporocarps in the specimen cited above, because we find the capillitium to have long, narrow free ends and a subreticulate spore ornamentation typical of *Trichia decipiens* var. *olivacea*.

In the Cuban reference to *Trichia verrucosa*, Farr (1976) mentions material from FH, but she does not indicate exsiccatae, neither does she comment. We suppose that her records for Cuba are based on her personal identification.

Farr (1976) noted the Cuban records of *Trichia varia* referred to by Berkeley (1869) and commented that "the Cuban record is marked with "?" because the Wright collections in FH were misidentified. Undoubtedly, however, this common and cosmopolitan species occurs on the island".

Massee (1892) mentions *Trichia fallax* Rost., which is currently considered to be a synonym of *T. decipiens*, but he did not indicate exsiccatae. Farr (1976) has not made observations on this material.

***Tubulifera microsperma* (Berk. & M.A. Curtis) Lado, Nomenmyx 16: 87. 2001**

FIGURES 25-26

- = *Licea microsperma* Berk. & M.A. Curtis in Berkeley, Grevillea 2: 68. 1873
- = *Tubifera microsperma* (Berk. & M.A. Curtis) G. W. Martin, Mycologia 39 (4): 461. 1947
- = *Licea stipitata* Berk. & Ravenel in Berkeley & Curtis, Proc. Amer. Acad. Arts 4: 125. 1860 [Nom. illeg., non *L. stipitata* DC., 1815]
- = *Tubulina stipitata* Berk. & Ravenel ex Rostaf., Sluzowce Monogr.:223. 1875
- = *Tubifera stipitata* (Berk. & Ravenel ex Rostaf.) T. Macbr., N. Amer. Slime-Moulds: 157. 1899

SPECIMENS EXAMINED — CUBA: ad lign: cariosum, leg. C. Wright (678), ex folder 193, B. & C. Fung. Cub. 551, FH as *Licea stipitata* Berk. & Ravenel. CUBA: on rotting wood, Jun 19, leg. C. Wright (677), Fungi Cubenses Wrightiani n° 551 (Gray Herbarium) FH as *Licea stipitata* Berk. & Ravenel. CUBA: leg. C. Wright (s/n), FH as *Tubifera stipitata* (Berk. & Ravenel) Macbr.

COMMENTS — Farr (1976) mentions *Tubifera microsperma* for Cuba based on Berkeley (1869), Massee (1892) and FH material. The collections "Wright 677" and "678" were cited by Berkeley (1869) as *Licea stipitata* Berk. & Ravenel. Later, Massee (1892) mentions the collection "Wright 677" as *Tubulina stipitata* Rost. We have not been able to find references of "Wright (s/n)" as *Tubifera stipitata*.

This species is easy to identify due to its small spores with a hemisphere completely reticulate and the internal part of the peridium with protuberances in the form of short tubes that resemble the suckers of octopus tentacles, easily visible by LM and SEM (Fig. 26).

Doubtful material:

Fourteen specimens examined in this study are doubtful, due in most cases to the scantiness of stored material or its absence.

Ceratiomyxa fruticulosa* f. *aurea (Link) Y. Yamam., The Myxomycete Biota of Japan (Tokyo): 40. 1998

= *Ceratiium aureum* Link, Magazin Ges. naturf. Freunde, Berlin 7: 39 (1816)

SPECIMENS EXAMINED — CUBA: without locality, on the roots of the coffee, 1865, leg. C. Wright 670, Plantae Cubenses Wrightianae (Gray Herbarium) FH as *Ceratiium aureum*.

COMMENTS — There is no material conserved, only imperfect fungi are present.

Craterium leucocephalum (Pers. ex J.F. Gmel.) Ditmar in Sturm, Deutschl. Fl. Pilze 1 (1): 21. 1812

= *Stemonitis leucocephala* Pers. ex J.F. Gmel., Syst. Nat. 2: 1467. 1792

= *Craterium minimum* Berk. & M. A. Curtis in Berkeley, Grevillea 2: 67. 1873

SPECIMENS EXAMINED — CUBA: 1857, leg. C. Wright (s/n), ex folder 186, Curtis Fungus Herbarium, FH as *Craterium minimum* Berk. & M. A. Curtis.

COMMENTS — Farr (1976) mentions *Craterium leucocephalum* for Cuba based on Berkeley (1869) and FH material without indicating exsiccatae. We could not examine FH material because there are no sporocarps.

Berkeley (1869) cites *Craterium leucocephalum* as “Wright 455”, but this collection number also appears to be given as *Didymium farinaceum* Fr. (see *D. farinaceum* in doubtful material). We cannot confirm the reference.

Craterium minimum Berk. & M.A. Curtis in Berkeley, Grevillea 2: 67. 1873

SPECIMENS EXAMINED — CUBA: 1857, leg. C. Wright, ex folder 186, Curtis Fungus Herbarium, FH.

COMMENTS — Only remains of a leaf without fructifications are conserved.

Didymium sp.

SPECIMENS EXAMINED — CUBA: leg. C. Wright (674), ex folder 179, Curtis Fungus Herbarium, FH. CUBA: leg. C. Wright (898) ex folder 179, Curtis Fungus Herbarium, FH. CUBA: on Cacao shells, on leaves & sticks among, Jan. 1857, leg. C. Wright (455), ex folder 179, No. 528 Curtis Fungus Herbarium, FH. Note: prematurely dried.

COMMENTS — In the specimens Wright 674 and 455 no material is conserved. In the specimen Wright 898 two very badly conserved sporocarps are present. Because of the very limited material no analysis was possible.

Didymium cinereum (Batsch) Fr., Syst. Mycol. 3: 126. 1829

SPECIMENS EXAMINED — CUBA: ad folia deject, leg. C. Wright (679), ex folder 179, n° 535 Curtis Fungus Herbarium, FH.

COMMENTS — No material is conserved.

Didymium farinaceum Schrad., Nov. Gen. Pl.: 22. 1797

SPECIMENS EXAMINED — CUBA: on old bark rope, Feb. 1857, *leg.* C. Wright (483), ex folder 179, n° 528 Curtis Fungus Herbarium, FH. Note: prematurely dried.

COMMENTS — The material is sclerotized, but the stalks are similar to the specimens “General Fungi Herb. 42” that correspond with *Physarum compressum* are observed.

Didymium furfuraceum (Schumach.) Fr., Syst. Mycol. 3: 116. 1829

SPECIMENS EXAMINED — CUBA: *leg.* C. Wright (907), ex folder 179, Curtis Fungus Herbarium, FH, revised by M.L. Farr 28-XI-1972, probably *Physarum compressum*.

COMMENTS — There is no material conserved.

Didymium herbarum Fr., Syst. Mycol. 3: 120. 1829

SPECIMENS EXAMINED — CUBA ORIENTALI: 1856-7, *leg.* C. Wright, Plantae Cubenses Wrightianae (Gray Herbarium) General Fungi Herb. 43. FH.

COMMENTS — The specimen lacks any material of the species in question.

Didymium polymorphum Mont., Ann. Sci. Nat. Bot., sér. 2. 8: 362. 1837

SPECIMENS EXAMINED — CUBA: old logs, Jan. 1857, *leg.* C. Wright (270), ex folder 179, n° 531 Curtis Fungus Herbarium, FH.

COMMENTS — Only some stalks are present, and these may represent *Physarum polycephalum*.

Didymium pruinosum Berk. & M.A. Curtis in Berkeley, J. Linn. Soc. Bot. 10: 348. 1868

SPECIMENS EXAMINED — CUBA: on sticks, Jan. 1857, *leg.* C. Wright (269), ex folder 179, n° 530 Curtis Fungus Herbarium, FH.

COMMENTS — Along with the identification “This is *Phys. nephroideum* Rost” there appear the initials “W.C.S.” in reference to Sturgis. This specimen was cited by Masee, Monogr. Myxogastr.:288 (1892)

There are only three fragments of stalks conserved. Because of the limited nature of the material no analysis it was possible.

Didymium squamulosum (Alb. & Schwein.) Fr., Symb. Gasteromyc.: 19. 1818

SPECIMENS EXAMINED — CUBA: *leg.* C. Wright (733), Plantae Cubenses Wrightianae n° 529 (Gray Herbarium) FH as “*Didymium radiatum* B. & C.”.

COMMENTS — In the specimen Wright (733) no sporocarps are conserved and only hypothalli and some stalks similar to those of *Didymium squamulosum* are present.

Trichia verrucosa Berk. in Hooker, Fl. Tasman. 2(9): 269. 1859

SPECIMENS EXAMINED — CUBA: Anana, *leg.* C. Wright, FH, only one slide as *T. varia* (Pers. ex J.F. Gmel.) Pers.

COMMENTS — This microscope slide was examined by M.L. Farr at 28-XI-1972 and identified as *T. verrucosa* (see the observations of *Trichia decipiens* var. *olivacea*).

After our study we think it may be *Trichia affinis* but, because of the limited material, we are unable to be certain.

Acknowledgements

This investigation has been partly financed by the Research Project of "Ministerio de Asuntos Exteriores" and "Ministerio de Ciencia y Tecnología, Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica REN2002-01965".

We express our gratitude to J.A. Pérez and A. Priego "Servicio de Microscopía Electrónica, University of Alcalá" for their invaluable help with the SEM, and wish to thank Dr. R.P. Korf, Dr. S. Stephenson and Mr. D.W. Mitchell, for the revision of the manuscript.

Literature Cited

- Alexopoulos CJ. 1969. The experimental approach to the taxonomy of the *Myxomycetes*. *Mycologia* 61(2): 219-239.
- Berkeley MJ. 1869. On a collection of fungi from Cuba. Part II. *J. Linn. Soc. Bot.* 10: 341-392.
- Camino M. 1998. *Myxomycetes* de Cuba . II. Orden *Stemonitales*. *Revista Jard. Bot. Nac. Univ. Habana* 19: 147-153.
- Camino M, Pérez JM. 2000. El género *Arcyria* Wiggers (*Trichiales* - *Myxomycetes*) en Cuba. *Revista Jard. Bot. Nac. Univ. Habana* 21 (1): 115-126.
- Camino M, Pérez JM. 2001. Los *Myxomycetes* de la Reserva Ecológica "Alturas de Banao" (El Naranjal) Sancti Spíritus. *Revista Jard. Bot. Nac. Univ. Habana* 22 (1): 109-117.
- Camino M, Moreno G, Castillo A, Illana C. 2003. Revision of the family *Stemonitaceae* in Cuba. *Mycotaxon* 88: 315-331.
- Castillo A, Moreno G, Illana C, Lago J. 1997. A critical study of some *Stemonitales*. *Mycol. Res.* 101: 1329-1340.
- Dörfelt H, Marx H. 1990. Zur Terminologie der sporenbildenden Stadien der Myxomyceten. *Beitr. Kenn. Pilze Mitteleurop.* 6: 5-14.
- Farr ML. 1958. Taxonomic studies in the *Myxomycetes*. I The *Trichia favoginea* complex. *Mycologia* 50: 357-369.
- Farr ML. 1976. *Myxomycetes*. In: *Flora Neotropica* 16. Cramer, N. Y. 304 pp.
- Ing B. 1964. *Myxomycetes* from Nigeria. *Trans. Brit. Mycol. Soc.* 47: 49-55.
- Kirk PM, Ansell AE. 1992. Author of fungal names. A list of authors of scientific names of fungi, with recommended standard forms of their names, including abbreviations. *Index of fungi*
- Koske, R.E. & B. Tessier (1983). A convenient permanent slide mounting medium. *Mycol. Soc. Amer. Newsletter* 34: 59.
- Lado C. 2001. Nomenmyx a nomenclatural taxabase of *Myxomycetes*. *Cuadernos de trabajo de Flora Micológica Ibérica* 16: 1-221.
- Lado C, Pando F. 1997. *Flora Mycologica Iberica*. Vol. 2. *Myxomycetes*, I. *Ceratiomyxales*, *Echinosteliales*, *Liceales*, *Trichiales*. Real Jardín Botánico Madrid, J. Cramer 323 pp.
- Lister A. 1894. A monograph of the *Mycetozoa*, being a descriptive catalogue of the species in the Herbarium of the British Museum. *British Museum (Nat. Hist.)* Cromwell road, London 224 pp.
- Lizárraga M, Illana C, Moreno G. 1999. SEM studies of the *Myxomycetes* from Peninsula of Baja California (Mexico), II. *Hemitrichia* to *Trichia*. *Ann. Bot. Fennici* 36: 187-210.
- Lizárraga M, Moreno G, Singer H, Illana C. 2003. *Myxomycetes* from Chihuahua, Mexico. *Mycotaxon* 88: 409-424.

- Martin GW, Alexopoulos CJ. 1969. The *Myxomycetes*. Univ. Iowa Press, Iowa City. 561 pp.
- Massee G. 1892. A monograph of the *Myxogastres*. Methuen & Co. London. 367 pp.
- Montagne JFC. 1845. Criptogamia o plantas celulares. In: Sagra, R. de la (ed.) Historia física, política y natural de la Isla de Cuba IX : 153-256.
- Moreno G, Lizárraga M, Illana C. 1997. *Metatrichia horrida* (*Myxomycetes*), an African species in the Baja California Peninsula (Mexico). Mycotaxon 64: 385-392.
- Nannenga-Bremekamp NE. 1974. De Nederlandse Myxomyceten. Koninklijke Nederlandse. Natururhistorische Vereniging. 460 pp.
- Pérez-Silva E, Herrera T, Esqueda M, Illana C, Moreno G. 2001. *Myxomycetes* of Sonora, Mexico. I. Mycotaxon 77: 181-192.
- Rammeloo J. 1975a. Structure of the epispore in the *Stemonitales* (*Myxomycetes*) as seen with the scanning electron microscope. Bull. Soc. Roy. Bot. Belgique. 45: 301-306.
- Rammeloo J. 1975b. Structure of the epispore in the *Trichiaceae* (*Myxomycetes*) as seen with the scanning electron microscope. Bull. Soc. Roy. Bot. Belgique. 107: 353-359.
- Rammeloo J. 1983. Flore Illustrée des Champignons d'Afrique Central. *Echinosteliales* et *Stemonitales* (*Myxomycetes*). Fascicule 11. Jardin Botanique National de Belgique. Meise. Bélgica.
- Rammeloo J. 1984. Icones Mycologicae 35-54. Jardin Botanique National de Belgique. Meise.
- Schnittler M, Novozhilov Y. 1996. The *Myxomycetes* of boreal woodlands in Russian northern Karelia: a preliminary report. Karstenia 36: 19-40.

MYCOTAXON

Volume 93, pp. 401–406

July–September 2005

A new species of *Leptosphaeria* (Ascomycotina, Pleosporales) on *Rosaceae* from Bolivia

MANUEL J. MACÍA¹, MARY E. PALM² & MARÍA P. MARTÍN¹

maripaz@ma-rjb.csic.es

¹Real Jardín Botánico de Madrid, C.S.I.C

Plaza de Murillo 2, 28014 Madrid, Spain

²USDA/APHIS, Systematic Botany and Mycology

Lab., Rm.329, B-011A, Beltsville, MD 20705-2350, USA

Abstract—*Leptosphaeria polylepidis* is described as a new species on *Polylepis tarapacana* from Sajama National Park in the Bolivian Andes at more than 4,000 m elevation. Diagnostic features are the long asci and the large, brown, 3-septate ascospores.

Key words— biogeography, conservation, rDNA, taxonomy

Introduction

The species of the genus *Polylepis* Ruiz & Pav. (*Rosaceae*: tribe *Sanguisorbeae*) grow naturally at high elevations, usually higher than any other arborescent plant, and occur in South America with the highest number of species in Bolivia, Ecuador, and Peru. It is an important plant in preventing soil erosion and land degradation as well as providing a good source of fuel and building supplies for local communities. Species of this genus are endangered in the Andean high regions and are listed as a primary genus to use in reforestation projects in the Andes (Brandbyge & Holm-Nielsen 1986). However, the regeneration of *Polylepis* largely has been unsuccessful due to cultural and biological factors, and forests continue to disappear at an alarming rate (Kessler & Driesch 1993). Thus, it is important to determine the regenerative needs of this genus as well as to identify pathogens that might reduce vigor and complicate regeneration efforts.

The Sajama National Park is located in the Bolivian Andes (Sajama Province, Oruro Department) and is a small reserve (1002 km²) created in 1939 to protect the *Polylepis tarapacana* Phil. vegetation formation. This small to medium sized tree or shrub, which is 1–3 m tall and popularly called keñua, is the main component of the world's highest woody plant formation at 5100 m (Jordan 1980; Kessler 1995). The mean annual temperature in the Sajama village is around 10 °C (range between –30 to 22 °C) and the mean annual precipitation is near 280 mm (range between 90–400 mm). In the Bosque de Keñua (18°08'S; 68°57'W), at 4300 m and likely with the highest

density of *P. tarapacana* in the region, some of the shrubs had black knots in both the apical and basal parts of branches (Fig. 1a). During a study of the systematics of *Polylepis* in Bolivia many branches were observed that were malformed due to black, irregular growths (Kessler, personal communication). It is likely that this disease killed a number of *P. tarapacana* trees but no published reports of these malformations or disease were found.

The growths on *Polylepis* resemble the black knot on plums and cherries caused by *Apiosporina morbosus* (Schwein.) Arx ($\equiv$ *Dibotryon morbosum* (Schwein.) Theiss. & Syd) (Ellis 2002). These growths also resemble those caused on the same host by *Grandigallia dictyospora* Barr et al. (1987). However, *Gr. dictyospora* produces very large galls, from 3–14 cm diam, and has larger ascospores that become densely muriform and break down internally, eventually producing numerous conidia inside the ascospore. In this paper, the probable casual agent of black knot on *P. tarapacana* is described as a new species and relationships discussed based on molecular analyses.

Materials and methods

Morphological characters were observed macroscopically and microscopically. All measurements of microscopic structures were made on material mounted in water. Light micrographs were captured using a QImaging MicroPublisher digital camera (QImaging, Burnaby, BC, Canada) that was mounted on an Olympus BX51 compound microscope as described in Díeguez-Urbeondo et al. (2003). All material is deposited in the herbarium MA-Fungi (Real Jardín Botánico de Madrid, Spain). Efforts to obtain this species into pure culture were unsuccessful.

The internal transcribed spacer regions of nrDNA (ITS1 and ITS2), including the 5.8S, were amplified using the primer pair ITS 1F (Gardes & Bruns 1993) and ITS 4 (White et al. 1990). All protocols are described in Martín, Raidl & Tellería (2004). Nucleotide BLAST searches with the option Standard nucleotide-nucleotide BLAST of BLASTN 2.26 were used to compare the sequence obtained in this study against other sequences in the National Center for Biotechnology Information (NCBI) nucleotide databases (Altschul et al. 1997). The new consensus sequence has been accessioned in the EMBL database with the Accession Number AJ786644.

Results

***Leptosphaeria polylepidis* M.J. Macía, M.E. Palm & M.P. Martín sp.nov.**

Figs. 1–2

Asci cylindrical-clavate, 8 spori, 185–200 x 28–35 µm. Ascospores fusiformes, brunneae, 3-septatae, 50–55 x 12–14 µm. Parasitatur in Polylepis tarapacana Phil., loco dicto Parque Nacional Sajama, Bolivia, supra 4300 m, IV/2002, M.J. Macía (Holotypus MA-Fungi 57843).

Etymology: from the name of the host *Polylepis tarapacana*

Ascomata aggregated, botryose, on well-developed, black stroma intermixed with plant tissue, superficial, black, surface cracked, 310–360 µm diam, 230–320 µm high,

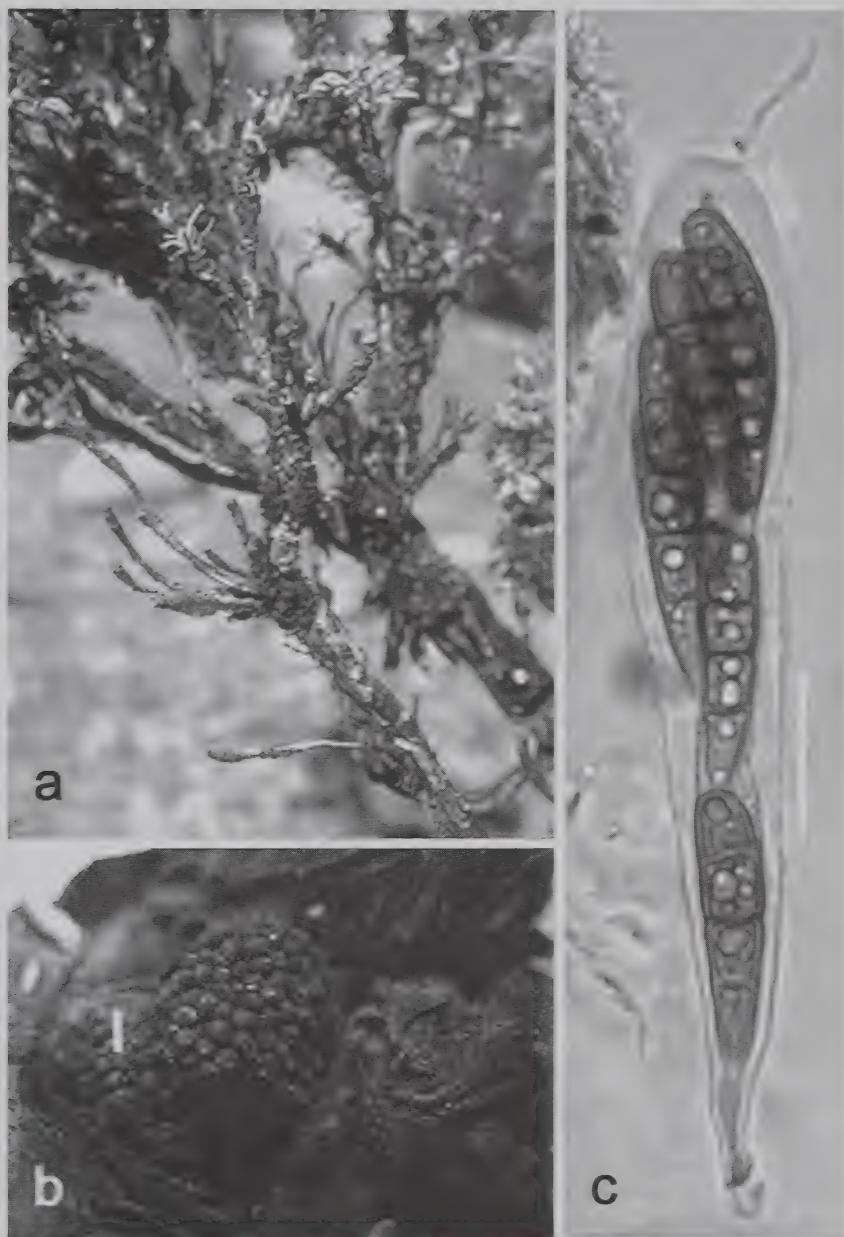


Fig. 1 *Leptosphaeria polylepidis*. a) Stromatic black knots on branches of *Polylepis tarapacana*. b) Papillate ascocarps (MA-Fungi 57843) (Bar=2 mm). c) Mature ascus (MA-Fungi 57843) (Bar=20 μ m).



Fig. 2 Line drawings of *Leptosphaeria polylepidis*. a) Asci. b) Ascospore (Bar= 20 μ m).

with broadly rounded papilla. Ascomatal wall of *textura angularis* in surface view; in longitudinal section 60–72 μ m thick, of 4–5 layers of polygonal, isodiametric to slightly elongate cells, 18–20 x 9–11 μ m, all layers with brown-melanized cells of scleroplectenchyma. Pseudoparaphyses 190–210 x 3.0–4.5 μ m wide, numerous, narrowly cellular, without gelatinous coating. Asci 185–200 x 28–35 μ m, numerous, basal, cylindrical-clavate, with 8 overlapping, uniseriate ascospores. Ascospores when immature 41–50 x 9–10 μ m, hyaline to subhyaline, at maturity 50–55 x 12–14 μ m, brown, narrowly fusiform, end cells acute, transversely 3-septate.

Material examined: Bolivia, Parque Nacional Sajama, on *Polylepis tarapacana*, 4300 m elev., IV/2002, leg. M.J. Macía 7507 (MA-Fungi 57843) (HOLOTYPE); 4800 m elev., IV/2002, leg. M.J. Macía 7508 (MA-Fungi 57842).

The Blast search of the sequence AJ786644 of *L. polylepidis* shows 92% similarity (392/426) to the sequence AF439461 of *Leptosphaeria dryadis* Rostr. (CBS 643.86) (Câmara et al. 2002).

Discussion

Huhndorf (1992) examined 28 species on *Rosaceae* with names in *Leptosphaeria* and found that five of those species belonged to *Leptosphaeria* Ces. & De Not. sensu Huhndorf. *Leptosphaeria polylepidis* differs from the species treated by Huhndorf (1992) namely *L. cercocarpi* Syd. & P. Syd., *L. doliolum* (Pers.) Ces. & De Not., *L. dryadis* (as *L. dryadophila* Huhndorf), *L. praetermissa* (P. Karst.) Sacc. and *L. umbrosa* Niessl, in the long asci and large, dark brown, 3-septate ascospores that are characteristic of this new species.

Based on comparison of the ITS sequence from this organism with the sequences in Genbank (EMBL), this species is most similar to *Leptosphaeria dryadis*. Chen et al. (2002) pointed out that *L. dryadis* is the correct name for *L. dryadophila* (basionym: *Melanomma dryadis* Johanson). *Leptosphaeria dryadis* occurs on *Dryas octopetala* L. at high latitudes mainly in Europe and is more common in arctic and subarctic areas than alpine zones according to Chlebicki and Suková (2004). *Leptosphaeria polylepidis* is ecologically similar to *L. dryadis* in that it grows at high altitudes.

Acknowledgments

Thanks to Dr. Amy Y. Rossman for her suggestions and comments during the preparation of this manuscript and Dr. Marcos P.S. Câmara for prepublication review. Thank you to Dr. Javier Dieguez-Urbeondo (RJB, Madrid) for Fig. 1c and to Dr. Miguel A. García for Fig. 1b. Thanks to Luis Miguel Monje and Teresa Valdecantos for their help in the fieldwork. This study was supported by Consejería de Educación, Comunidad de Madrid, Spain (to MJM).

Literature Cited

- Altschul SF, Madden TL, Schäffer AA, Zhang J, Zhang Z, Miller W, Lipman DJ. 1997. Gapped BLAST and PSI-BLAST: a new generation of protein database search programs. *Nucleic Acids Res.* **25**: 3389-3402.
- Barr ME, Hanlin RT, Cedeno L, Parra J, Hernandez R. 1987. A spectacular loculoascomycete from Venezuela. *Mycotaxon* **29**: 195-198.
- Brandbyge J, Holm-Nielsen LB. 1986. Reforestation of the high Andes with local species. Reports from the Botanical Institute, University of Aarhus **16**: 1-114.
- Câmara MPS, Palm ME, van Berkum P, O'Neill NR. 2002. Molecular phylogeny of *Leptosphaeria* and *Phaeosphaeria*. *Mycologia* **94** (4): 630-640.
- Chen C-Y, David, JC, Hsieh, WH 2002. *Leptosphaeria dryadis*. I.M.I. Descr. **1533**: 1-2.
- Chlebicki A, Suková M. 2004. Fungi of 'alpine islands' of *Dryas octopetala* in the Carpathians. *Mycotaxon* **90**: 153-176.
- Diéguez-Urbeondo J, Föster H, Adaskaveg JE. 2003. Digital image analysis of the internal light spots of appressoria of *Colletotrichum acutatum*. *Phytopathology* **92**: 923-930.
- Ellis MA. 2002. Black knot of plums and cherries. FactSheet HYG-3011-94. <http://ohioline.osu.edu/>.

- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. *Molecular Ecology* **2**: 113-118.
- Huhndorf SM. 1992. Systematics of *Leptosphaeria* species found on *Rosaceae*. Illinois Nat. History Survey Bull. **34** (5): 479-534.
- Jordan E. 1980. Das durch Wärmemangel und Trockenheit begrenzte Auftreten von *Polylepis* am Sajama Boliviens mit dem höchsten *Polylepis*-Gebüschvorkommen der Erde. Deutsch. Geographentag **42**: 303-305.
- Kessler M. 1995. The genus *Polylepis* (*Rosaceae*) in Bolivia. *Candollea* **50**: 131-171.
- Kessler M, Driesch P. 1993. Causas e historia de la destrucción de bosques altoandinos en Bolivia. *Ecología en Bolivia* **21**: 1-18.
- Martín MP, Raidl S, Tellería MT. 2004. Molecular analyses confirm the relationship between *Stephanospora caroticolor* and *Lindtneria trachyspora*. *Mycotaxon* **90** (1): 133-140.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In PCR protocols. A guide to methods and applications (eds. Innes, M.A., Gelfand, D.H., Sninsky, J.J. & White T.J.), pp. 315-322. Academic Press, Inc.: San Diego, California.

Reinventing taxonomy: a curmudgeon's view of 250 years of fungal taxonomy, the crisis in biodiversity, and the pitfalls of the phylogenetic age¹

RICHARD P. KORF

director@exeisland.com RPK1@cornell.edu
Director, Exe Island Biological Station, P.O. Box 64
Portland, ON, Canada K0G 1V0

Emeritus Professor of Mycology, Plant Pathology Herbarium
Cornell University, Ithaca, NY 14853, USA

Abstract — Biological taxonomy is bleeding. The fungi are but one example. There is an almost ignored crisis of impending loss in biodiversity, while the funding—necessary to provide basic inventories and monographic studies—is simultaneously siphoned away by the misuse of the great potentials of molecular biology. One disturbing result has been frequent support of needless, repetitive phylogenetic studies. A seminal paper, “Taxonomic triage and the poverty of phylogeny,” by entomologist Quentin D. Wheeler, is cited as required reading for all biologists. His theses are that “Taxonomy, already weakened by decades of neglect, now suffers the loss of positions and funding,” and that “Considering what is at stake for human and environmental welfare in the biodiversity crisis, it is time to triage and move descriptive taxonomy to the forefront of science funding priorities.” Reinventing taxonomy may provide answers.

Key words — collecting, monographs, inventories, PhyloCode, DNA

Introduction

The title of this paper refers to this as “a curmudgeon’s view.” I have intentionally used the phrase that was also part of the title of an address I gave at the Seventh International Mycological Congress (Korf, 2002), in which I noted: “The noun curmudgeon is defined and used here in two, not necessarily exclusive, ways: *n.* 1. *archaic*: a crusty, ill-tempered, churlish old man. 2. *modern*: (i) anyone who hates hypocrisy and pretense and has the temerity to say so; (ii) anyone with the habit of pointing out unpleasant facts in an engaging and humorous manner.” Let us hope that I succeed here to fit one or both of those modern options.

I intend to look here at taxonomy as practiced for the past 250 years in the field of mycology, to trace its roots and highpoints, and to point to the inescapable truth that

¹Based on an invitational paper delivered at the meetings celebrating the 100th Anniversary of the Danish Mycological Society, Copenhagen, Denmark, on October 1, 2005.

all taxonomy must now reinvent itself and regain its *primary function* in biology. To these ends I shall briefly review the mycological terrain from the days of Linnaeus to the golden explosion at the time of Persoon and Fries in the early 19th century, through the comparative morphological studies of the next century, through the dark days of the New Systematics, and the fortunate birth of Hennig's *Phylogenetic Systematics*. In the last 30 years the decline in taxonomic work has been catastrophic, to the point that taxonomy is today potentially bleeding to death.

Much of what I have to say has recently been covered in great depth by a former colleague of mine at Cornell University, Quentin D. Wheeler, a brilliant taxonomist and entomologist and now Keeper of the insect collection at the British Museum, in a seminal paper entitled *Taxonomic triage and the poverty of phylogeny* (Wheeler, 2004), a paper I consider required reading for all biologists. Throughout my remarks I shall cite this paper frequently, and if all anyone remembers of my analysis is his paper, I shall be satisfied.

Following the introductory historical view, I shall discuss critical areas of what we must now reemphasize: the crisis in biodiversity and the need for collecting, the production and the importance of monographs and of inventories; as well as of what we need to deemphasize: DNA Taxonomy and the PhyloCode, plus much of the unproductive phylogenetic biology now so bandwagon popular; of how funding must be redirected for the good not only of taxonomy but of phylogenetic systematics; and of how taxonomic renaissance must be mounted.

A brief history of 250 years of mycological taxonomy and its technologies

Though Linnaeus' work (1753) is now the official starting point for all mycological taxonomy, he was by no means the earliest to record fungi, nor indeed is he considered to have been well-versed in fungi. His major contribution was the development of the system of binomial nomenclature that has stood the test of time as adaptive to advancing knowledge and allowing the proposal of hypotheses of relationships at all levels. The preeminence of two mycologists, Christiaan Hendrick Persoon [1761–1836] and Elias Magnus Fries [1794–1878], aptly called the “fathers of mycology,” overshadows many others of the early 19th century. They and the others of this exciting time of discovery based their species, genera, and higher ranks on comparative morphology, often aided by developments in microscopy. The intent was almost always to provide a classification that reflected relationships, deduced from comparative morphology. A few systems were proposed that attempted to replace such phylogenetic hypotheses by numerical arrangements, and a major compiler of descriptions, Pier Andrea Saccardo [1845–1920], was wedded to the idea that spore septation, shape, and coloration were dominant features by which fungi should be catalogued. His thinking adversely affected generations of mycologists, and one can justly refer to “the dead hand of Saccardo on the advancement of fungal taxonomy.”

The use of chemotaxonomy began early, with a few chemicals, and expanded primarily with lichenized fungi to a degree astounding to most non-lichenologists. The

reliance on the presence or absence of specialized lichen-substances as diagnostic tools for species (and generic) identification still remains an anachronism for many of us. Genetics as a tool in taxonomy began in the early 1930's, and mating systems rightfully remain one of the tools some taxonomists still use for species distinction. Reproductive isolation does not always, however, precede speciation, especially in allopatry (Coyne & Orr, 2004). Mycological taxonomists anxious to develop systems of classification that reflect phylogeny have exploited each and every tool that seemed to promise *predictive value*.

The largest blow to taxonomy came with *The New Systematics*, in which, in Wheeler's (2004) words, "Mayr (1942, p. 7) belittled traditional taxonomy.... Since that time, the goals of taxonomy have been confounded with those of related areas of science whether population biology, tropical biology or molecular biology and few individual or institutional voices have made unapologetic assertions of the importance and credibility of taxonomy for its own sake.... Although Hennig (1966) returned respectability to studies at and above the species level, taxonomy has never fully recovered from being thus tainted as non-scientific (even non-biological!)." We have seen many new tools, have their brief day in the sun, each in turn touted as "cutting edge." These include technologies, *e.g.*, electron microscopy (first TEM, then SEM), isozymes, RFLPs—then RAPDs and cognate approaches such as AFLPs, and now DNA sequence polymorphisms particularly in the nuclear ribosomal DNA repeat. These tools include schools of analysis, such as phenetics, cladistics, and recently Bayesian statistics. DNA sequence data have facilitated the inference of phylogenetic trees resulting in proposals for realignment of many taxa, (sometimes generating nomenclatural consequences that have yet to be proven correct). New combinations and new arrangements have been proposed on the basis of a study of far too few genes and consideration of far too few taxa.

There is a balance to be found between the quantity and the quality of informative characters and the number and distribution of taxa sampled. Higher standards are required. One of the reviewers of this paper believes that we will look back on the recent era of the molecular-phylogeny bandwagon as quaint and not very enduring. He points to some serious and excellent phylogenetic studies, including the exceptional one by Rokas et al. (2003) on a 100+ gene phylogeny of *Saccharomyces* species, which advocates 20-or-more simultaneous gene analyses.

Single-gene phylogenies have often been confused with species phylogenies. This is the sorry state in which we find mycological taxonomy today, forty years since Hennig and the promises his work provided. Molecular biologists have criticized taxonomists for conducting descriptive work, yet much of molecular biology is descriptive and *not* hypothesis-driven. Good science is, unequivocally, hypothesis-driven.²

²One may wonder what a hypothesis is in a taxonomic study. Implicit in a phylogenetic study is the hypothesis of monophyly - for any taxon in the hierarchy. Other hypotheses would be associations with morphology or ultrastructure (the dolipore septum was acquired once in Phylum X), or nutritional mode (the lichen symbiosis has evolved once in Family Y), or physiology (members of Genus Z all degrade cellulose by one common enzymatic pathway) or pathogenicity (species of Genus Q have co-specified with their hosts).

Taxonomists today are almost afraid to label themselves as that. Once more I quote from Wheeler (2004): “Mayr’s (1942) “population thinking” led thinkers in systematics to coin the term “biosystematists” to distinguish themselves from traditional taxonomists. Today, “tree thinking” has led to a segregated study of phylogeny that may, according to O’Hara (1997), be the beginning of another new splinter science. Once again a new name, phylogenetic biologist, distances these tree thinkers from taxonomy.”

The crisis in biodiversity

Surely all taxonomists are aware of the crisis that we face in biodiversity. An oft-quoted estimate for fungi is that we have described only 4 to 5% of the world’s species, leaving 95% or more yet to be recorded. The loss of habitats is proceeding so swiftly that the problem is critical. Unless these habitats are sampled now we will have lost forever our chance to document the world’s living biodiversity, to save that in museum specimens and, in the case of fungi, often in culture collections. To do that documentation requires an immense increase in the number of taxonomists and parataxonomists able to collect and identify the taxa. With the number of taxonomists dwindling each year, and with many of these now engaged only in *studies of known taxa* and who display no interest in the undescribed ones, we have little chance to survive the crisis with honor. Those who follow us will bemoan our lack of foresight in documenting the very diversity that could yield the answers to life on earth, past and future.

The answer is so simple it is easy to overlook. We *must* collect, collect, and collect. We need to spend our monies collecting, and to train our students to leave the air-conditioned laboratory and to go out into the field, from the frozen arctic to the humid tropics. Without documented specimens no assay of biodiversity has meaning. In Wheeler’s (2004) words, “Although the most visible products of alpha taxonomy are specimens, their associated data will be increasingly valuable as the biodiversity crisis progresses.” Specimens typically carry with them immense amounts of data on ecology, geography, and the environment that are critical for any modern biological investigation.

The biodiversity crisis pervades most of the issues I am discussing in this paper.

On monographs and inventories

I single out the importance of monographs and inventories because without them no real progress in taxonomy (nor also in phylogenetic biology) can ever occur. Monographs are the summation of scattered reports of species and subordinate taxa, carefully reconsidered and revisited. Given the paucity of taxonomists, few fungal groups ever get a substantial revisionary study even once or twice in a century. Monographs are the essential tools for progress in understanding biodiversity. Similarly, checklist inventories that do more than merely listing species determined and do include ecological and critical morphological data, contribute importantly to the summation of knowledge. It has long been my belief that monographic study on a not-too-large group remains the best subject for a doctorate thesis in taxonomy, providing the student with

the intellectual tools to investigate the past, and to learn the processes of discrimination, synonymy, and the intricacies of nomenclature.

Some pitfalls of the phylogenetic age: avoiding DNA taxonomy and the folly of the PhyloCode

Wheeler (2004) hit it on the head. “Well-intentioned proposals for a DNA-based taxonomy present a new and growing threat to the advance of taxonomy. Although DNA barcoding is an exciting new identification tool for taxonomy, it lacks the theoretical base for taxonomy and, unless handled rationally, could undermine the intellectual content of taxonomy making it a service industry providing an inferior service (Lipscomb. *et al.* 2003). DNA is simply data.” To me, it is clearly impossible to equate DNA sequences with taxonomic insights.

An even worse pitfall is the PhyloCode and its absurd rankless classifications. It seems incredible that a whole school of well-intentioned biologists has wasted countless time and effort on such a proposal, antithetic to the whole concept of hierarchal taxonomy that has served us so well for so long. I shall make no attempt here to do more than ask you to read Wheeler’s (2004) comments, summed up as “what the PhyloCode seeks to do does not need to be done and what it claims to do it does not. Taxonomy faces important and exciting intellectual and scientific challenges and should waste no more effort on what Carpenter (2003) aptly describes as ‘pure folly.’”

On funding

The individual taxonomist faces an almost impossible task these days to fund collecting trips for her/himself and for graduate students and postdoctoral students. When I was supported by the National Science Foundation (NSF) for many years from the 1960’s till the 1980’s, obtaining funding for collecting in Asia, the Caribbean, and Macaronesia was very easy, perhaps because it cost so little to do. I took one student for a year to Asia, and up to six at a time for two-week trips to the Caribbean and the Bahamas, and finally 4 scientists at a time for three month-long trips to Macaronesia. We skimmed by on very modest hotel rooms where we would study, document, and sometimes photograph specimens, often culturing them, and setting them to dry, from after dinner till midnight or later. We would arise by 6 am to go out in the field to collect all day, often lunching on slabs of bread, cheese, sausage, and a bottle of wine. The cost per specimen collected was minimal, and to this day the specimens we collected are being cited regularly in papers worldwide since many of the places we went were and still are only poorly-collected. The only grants that NSF supported in later years (when my applications were no longer funded) were *required* to have a molecular and phylogenetic component. Those that were funded, primarily phylogenetic studies, had budgets ten to fifty times the funding I had requested. Few of the successful grants in the 80’s and 90’s ever generated many new specimens, but did support comparatively expensive molecular analyses and equipment.

On the “bean-counting” mentality

Probably the most distressing aspect of the current scene in biology is the “bean-counting mentality” rampant in research institutes and universities worldwide. Under that mind-set many of us are now evaluated, compensated, employed, and given or not given tenure on the strength of ill-founded formulas in which ridiculous journal impact factors, numbers of papers, and grant monies are the variables. Given that an excellent monograph can be equivalent in research hours to 5–10 papers documenting single species descriptions or non-taxonomic research, and is likely to be published in a journal with a modest “impact factor” yet accrue citations over a time scale of many decades, not years, taxonomists will not be favored by the bean counters.

Towards a taxonomic renaissance

The sad truth is, in Wheeler’s (2004) words, “The diversion of funds from taxonomy to phylogenetic biology is an international phenomenon.” I know this to be a fact for the UK, Canada, the United States, and China. Nonetheless, I am deeply heartened as I see alpha taxonomic mycological work still being supported in most of Europe. Resources there are still being used for impressive monographic book-length studies like those of the *Flora Agaricina Neerlandica*, for the many superb volumes produced by the Centraalbureau voor Schimmelcultures, with others from France, Scandinavia, Switzerland, and especially Italy’s Associazione Micologica Bresadola. Alpha taxonomy is alive and well in the professional mycological journals of Britain, the Czech Republic, Estonia, France, Germany, the Netherlands, Scandinavia, and Switzerland, as well as in Asia (China, Japan, Korea). Much more evident is the quality alpha taxonomy that is being published throughout Europe by societies that are essentially manned by amateurs ably assisted by professionals: journals like Belgium’s *Miscellanea Micologica*, Denmark’s *Svampe*, France’s *Bulletin Mycologique et Botanique Dauphiné-Savoie*, Germany’s *Mycologia Bavarica*, Italy’s *Rivista di Micologia*, and Spain’s *Boletín de la Sociedad Micológica de Castellana*, to name but a few, whose pages abound with excellent photographs and frequently artistically produced line drawings. Couple that with some of the web-based bulletin boards (ASCOFrance comes immediately to mind) where amateurs and professionals can chat at length about their exciting finds and you can see why I have such faith in these alternatives to grant-financed phylogenetic papers and to symposia that add *so little* to the taxonomic imperative.

As an American I can only hang my head in shame at the lack of such publications by our amateur societies.³ Europe, on the other hand, clearly continues to nurture the naturalist’s involvement in taxonomy, as it has successfully done for the last century.

³ Some alpha taxonomic works are accepted both in *Mycologia* (which has suffered from a lack of taxonomically-trained and nomenclaturally-savvy editors in recent years), and in the *Canadian Journal of Botany*. My Belgian colleague, Grégoire L. Hennebert, and I founded what may be the only strictly taxonomic/nomenclatural mycological journal, *Mycotaxon*, in 1974. It has recently revisited its focus (taxonomy and nomenclature) and now excludes purely phylogenetic papers. Instead of hard-copy checklists, it encourages *web-based* checklists that can be frequently updated.

In my deep concern for the need to redirect funding towards collecting, comparative morphology, and monographic studies, my unstated but equal concern for effective support of phylogenetic biology and genomics may appear to be lost. The contributions of these new technologies have been not only exciting but also illuminating, and intellectually stimulating. Nevertheless, phylogenetic studies mean nothing if the data on which they are based is flawed. As Wheeler (2004) points out, "Continuing emphasis on the mere computerization of label data from museums and herbaria is misguided, when eight out of ten records may be mistaken. There is little benefit in rapid electronic access to unreliable data." Amen.

When taxonomists examine herbarium specimens, confirmation of identifications should be part of the deal. If molecular phylogeneticists capture a misidentification, what is the process? For that matter, are we vigilant on re-annotation of GenBank sequences when misidentifications are discovered? (My information is that only the original depositor can correct the identification of a GenBank entry.)

The huge sums supplied by the National Science Foundation (NSF) to support ATOL (Assembling the Tree of Life) (\$8 million in 2002, \$12 million in 2003), or in the case of fungi, the Deep Hypha program—with many good aspects—may be deeply compromised by the few taxa involved. As one of my reviewers of this paper noted, "alpha taxonomy can both *enhance* Deep Hypha and remediate its shortcomings." The problems of missing taxa are well summed up in Wheeler's (2004) words, "Although the precise impact of species excluded from an analysis varies from case to case, there is general agreement that such missing taxa are a serious concern to the recovery of phylogenetic patterns (e.g. Novacek 1992; Wheeler 1992; Graybeal 1998; Hillis 1998; Hillis *et al.* 2003). For all but a few relatively well-known small clades, this ignorance of species diversity will pose an impediment to resolving phylogenetic relationships.... and phylogenies will be subject to frequent and major reorganizations."

A recent turn-about in NSF's priorities must be fully applauded: The PEET (Partnerships to Enhance Expertise in Taxonomy) program for training young taxonomists, and NSF's funding of Revisionary Syntheses in Systematics as well as their Planetary Biodiversity Inventory are important steps in the right direction. That some of these were implemented during Quentin Wheeler's three-year stint at NSF is not mentioned in his 2004 paper. Credit belongs to him and to his colleagues at NSF, Diana Lipscomb and Norm Platnick.

That in this day an alpha taxonomist can scarcely find a position in our universities is distressing. Positions in museums where there is time to generate monographs are equally hard to find. Where will universities and public museums find the money to support descriptive taxonomy? Wheeler (2004) has some cogent comments: "To meet the biodiversity crisis, taxonomy must rapidly transform to become big science. Its guiding agenda, after all, is to fully discover and describe the species of an entire planet. If it is worth billions to determine whether there is or ever was life on Mars, it is surely worth more to document the results of tens of millions of years of evolution on Earth.... Taxonomy not only deserves support, it deserves massive support to meet this last ditch effort to document species."

Are the people at NSF or the National Institutes of Health in the US, or the granting agencies in the U.K. listening? Or, for that matter, is even your university or mine listening? Will budding fungal taxonomists recognize that alpha taxonomy is indeed more “cutting edge science” and definitely more crucial in this era of biodiversity crisis than any seductive phylogenetic studies in an air-conditioned laboratory? I’m keeping my fingers crossed.

I close with this advice to young fungal taxonomists: (a) forget the lure of instant fame in following the latest technological fad, but instead (b) go out into the field and collect, take ample notes, culture if possible, study—if you can take along a field microscope—while your specimens are alive (Baral, 1992) and while you simultaneously swat mosquitoes in a tropical rain forest, (c) learn to love sleuthing in the stacks of a good library as well as on the internet, (d) scour the world’s herbaria, (e) publish even if you feel you are only 95% correct, much preferable to being a perfectionist that never publishes—one whose data dies with himself or herself, (f) never be the graduate student who emails a scientist asking for cultures if you are incapable of doing your own fieldwork, of identifying specimens, and of using the taxonomic literature, and, (g) *above all*, leave a luxurious legacy of data for future taxonomists to build upon.

Whether you are working in a museum or in an academic position, maintain your central goals of producing the finest and most useful monographs, species descriptions, and floristic studies. Develop collaborations with your ecologist colleagues and build on the role that many fungi play in ecosystem function to make the strongest case for research funding. Forge collaborations between taxonomists and phylogeneticists that will get money to the taxonomists so that there is some product for posterity from their phylogenetic approximations. Collaterally, publish in the widest assortment of journals. Talk back to the bullies and to the “bean counters” and make the case for excellent, hypothesis-driven research in all areas of science — and make your own work an example.

Acknowledgements

I am deeply indebted to the Danish Mycological Society for its invitation to present this talk by a scientist well beyond his prime, and for providing funds to allow this to happen. I also thank my pre-presentation reviewers, Professors James B. Anderson and Linda M. Kohn, for their critical insights and suggestions for improvements, many (but not all) of which I have embraced. In many cases I adopted the wording they proposed as if it were my own. I had chosen them *not* because they were likely to think as I do, but primarily because they know much more about phylogenetic biology than I ever did. In addition, both are clear thinkers capable of spotting flaws in my reasoning.

Literature Cited

- Baral H-O. 1992. Vital versus herbarium taxonomy: morphological differences between living and dead cells of ascomycetes, and their taxonomic implications. *Mycotaxon* **44**: 333-390.
- Carpenter JM. 2003. Critique of pure folly. *Bot. Rev.* **69** 79-92.
- Coyne JA., Orr HA. 2004. *Speciation*. Sinauer, Sunderland, MA.
- Graybeal A. 1998. Is it better to add taxa or characters to a difficult phylogenetic problem? *Syst. Biol.* **47**: 9-17.

- Hennig W. 1966. *Phylogenetic systematics*. University of Illinois Press, Urbana, IL.
- Hillis DM. 1998. Taxonomic sampling, phylogenetic accuracy, and investigator bias. *Syst. Biol.* **47**: 3-8.
- Hillis DM, Pollock DD, McGuire JA, Zwick DJ. 2003. Is sparse taxon sampling a problem for phylogenetic inference? *Syst. Biol.* **52**: 124-126.
- Korf RP. 2002. A curmudgeon's view of priorities and economics. IMC7 Book of Abstracts, Seventh International Mycological Congress, p. 20.
- Linnaeus C. 1758, *Systema naturae*. Ed. 10, Stockholm.
- Lipscomb D, Platnick N, Wheeler QD. 2003. The intellectual content of taxonomy: a comment on DNA taxonomy. *Trends Ecol. Evol.* **18**: 57-59.
- Mayr E. 1942. *Systematics and the origin of species*. Columbia University Press, New York.
- Mayr E. 1982. *The growth of biological thought*. Harvard University Press, Cambridge.
- Novacek MJ. 1992. Fossils, topologies, missing data, and the higher level phylogeny of eutherian mammals. *Syst. Biol.* **41**: 58-73.
- O'Hara RJ. 1997. Population thinking and tree thinking in systematics. *Zool. Scripta* **26**: 323-329.
- Rokas A, Williams BL, King N, Carroll S. 2003. Genome-scale approaches to resolving incongruence in molecular phylogeny. *Science* **425**: 789-804.
- Wheeler QD. 2004. Taxonomic triage and the poverty of phylogeny. *Phil. Trans. R. Soc. London B* **359**: 571-583.
- Wheeler WC. 1992. Extinction, sampling, and molecular phylogenetics. In *Extinction and Phylogeny* (ed. Novacek MJ, Wheeler QD) pp. 205-325. Columbia University Press, New York.

Nomenclatural novelties proposed in Mycotaxon 93

- Albatrellus ginsii*, A.B. De, p. 123
Alternaria impatientis X. Sun & T.Y. Zhang, p. 283
Alternaria pharbitidicola X. Sun, Meng Zhang & T.Y. Zhang, p. 285
Anthracoidea macranthae L. Guo & S.R. Wang, p. 160
Ascocoryne striata (Ellis & Everh.) V. Kučera & Lizoň, p. 163
Canalisporium panamense A. Ferrer & Shearer, p. 180
Cercospora agavicola Ayala-Escobar, p. 117
Entyloma martindalei (Peck) Piątek, p. 324
Fuscolachnum hainesii Chleb. & Suková, p. 106
Hemithecium amboliens Makhija & Dube, p. 367
Hemithecium consociatum Makhija & Dube, p. 362
Hemithecium nakanishianum (Patw. & C.R. Kulk.) Makhija & Dube, p. 371
Hemithecium norsticticum Makhija & Dube, p. 370
Hymenogaster raphanodorus M.E. Sm. & Trappe, p. 242
Hypoderma qinlingense Y.M. Liang & C.M. Tian, p. 310
Incrucipulum uralense (Chleb.) Chleb. & Suková, p. 109
Inocutis subdryophila Y.C. Dai & H.S. Yuan, p. 168
Lacrymaria hypertropicalis (Guzmán, Band.-Muñoz & Montoya) Cortez, p. 130
Lepraria goughensis Elix & Øvstedal, p. 274
Leptosphaeria polylepidis M.J. Macía, M.E. Palm & M.P. Martín, p. 402
Melanogaster utriculatus Y. Wang, Castellano & Trappe, p. 315
Microbotryum bardanese Chleb. & Suková, p. 150
Morchella bicostata J.Y. Chen & P.G. Liu, p. 89
Penicillium brevistipitatum L. Wang & W.Y. Zhuang, p. 234
Phoma billsii J.F. White, p. 300
Phragmidium hendersonii Bahç. & Kabaktepe, p. 327
Plenodomus morganjonesii M.S. Torres & J.F. White, p. 336
Polyporus jianfenglingensis (G.Y. Zheng) H.D. Zheng & P.G. Liu, p. 260
Polyporus subg. *Astropolyporus* R.M. Silveira & J.E. Wright, p. 9
Polysporina oligospora (H. Magn.) K. Knudsen, p. 278
Psilocybe rickii Guzman & Cortez, p. 96
Puccinia asyneumatis Bahç. & Kabaktepe, p. 328
Puccinia gjaerumii Bahç. & Kabaktepe, p. 329
Rhizopogon ater Trappe & Grubisha, p. 346
Rhizopogon brunsi Grubisha & Trappe, p. 350
Scutellinia korfiana W.Y. Zhuang, p. 99
Spooneromyces daliensis (W.Y. Zhuang) W.Y. Zhuang, p. 103
Steccherinum subglobosum H.S. Yuan & Y.C. Dai, p. 174
Steccherinum subulatum H.S. Yuan & Y.C. Dai, p. 176
Sulcatistroma A.W. Ramaley, p. 140
Sulcatistroma nolinae A.W. Ramaley, p. 140
Tuber furfuraceum H.T. Hu & Y. Wang, p. 155
Vizella philotheae Cunningham, p. 135

Author Index—Volume 93

- Adawadkar, Bharati, see Makhija & al.
- Afyon, Ahmet, Muhsin Konuk, Dursun Yağiz & Stephan Helfer. A study of wood decaying macrofungi of western Black Sea Region, Turkey. 93: 319–322. 2005.
- Akgül, Hasan, see Ergül & al.
- Aslan, Ali, see Yazıcı & Aslan
- Ayala-Escobar, Victoria, María de Jesús Yañez-Morales, Uwe Braun, Johannes Z. Groenewald & Pedro W. Crous. *Cercospora agavicola* – a new foliar pathogen of *Agave tequilana* var. *azul* from Mexico. Mycotaxon 93: 115–121. 2005.
- Bahçecioglu, Zeliha, Sanlı Kabaktepe & Bayram Yıldız. Three new rust species (*Uredinales*) from Turkey. 93: 327–331. 2005.
- Bergen, Marshall, see Torres & al.
- Beyerle, Adrian R., see Grubisha & al.
- Bischoff, Joseph F., see Torres & al.
- Braun, Uwe, see Ayala-Escobar & al.
- Camino, M., G. Moreno & A. Castillo. Taxonomic revision of the myxomycetes from Cuba deposited in the Farlow Herbarium (USA). 93: 379–400. 2005.
- Campbell, S.D., see Liberato & al.
- Cao, Zhi-Min, see Liang & al.
- Castellano, Michael A., see Wang & al.
- Castillo, A., see Camino & al.
- Cazares, Guadalupe, see Torres & al.
- Chen, Jian-Bin & Theodore L. Esslinger. *Parmeliaceae* (Ascomycota) lichens in China's mainland. IV. *Melanelia* species new to China. 93: 71–74. 2005.
- Chen, Ji-Yue, & Pei-Gui Liu. A new species of *Morchella* (*Pezizales*, Ascomycota) from southwestern China. 93: 89–93. 2005.
- Chitale, Gayatri, see Makhija & al.
- Chlebicki, Andrzej, & Markéta Suková. On three foliicolous *Hyaloscyphaceae* on *Dryas*. 93: 105–113. 2005.
- Chlebicki, Andrzej & Markéta Suková. Two *Microbotryum* species from the Himalayas. 93: 149–154. 2005.
- Coelho, Gilberto, see Cortez & Coelho
- Cortez, Vagner Gualarte, & Gilberto Coelho. A new combination in *Lacrymaria* (*Agaricales*). 93: 129–134. 2005.
- Cortez, Vagner Gualarte, see Guzmán & Cortez
- Crous, Pedro W., see Ayala-Escobar & al.
- Cunnington, James. A new species of *Vizella* from Australia. 93: 135–138. 2005.
- Dai, Yu-Cheng & Hai-Sheng Yuan. *Inocutis subdryophila* (Basidiomycota), a new polypore from China. Mycotaxon 93: 167–171. 2005.
- Dai, Yu-Cheng, see Yuan & Dai
- De, A.B. *Albatrellus ginnsii* sp. nov. 93: 123–128. 2005.
- Dube, Archana, see Makhija & al.
- Dülger, Başaran, see Ergül & al.
- Elix, John A., Dag Olav Øvstedal & Niek J.M. Gremmen. A new *Lepraria* species from Gough Island, South Atlantic Ocean. 93: 273–275. 2005.

- Elshafie, Abdulkadir E. Coprophilous mycobiota of Oman. 93: 355–357. 2005.
- Ergül, C. Cem, Başaran Dülger, R. Batur Oran & Hasan Akgül. Myxomycetes of the Western Black Sea Region of Turkey. 93: 269–272. 2005.
- Esslinger, Theodore L., see Chen & Esslinger
- Ferrer, Astrid & Carol A. Shearer. New records and a new species of *Canalisporium* from aquatic habitats in Panama. 93: 179–188. 2005.
- Groenewald, Johannes Z., see Ayala-Escobar & al.
- Gremmen, Niek J.M., see Elix & al.
- Grubisha, Lisa C., James M. Trappe, Adrian R. Beyerle & Dan Wheeler. NATS truffle and truffle-like fungi 12: *Rhizopogon ater* sp. nov. and *R. brunsi* sp. nov. (*Rhizopogonaceae*, Basidiomycota). 93: 345–353. 2005.
- Guo, Lin & Shengrong Wang. A new species and a new record of *Anthracoidea* (*Ustilaginales*) from China. 93: 159–162. 2005.
- Guttová, Anna & Per Magnus Jørgensen. *Leptogium diffractum* in Slovakia and Czech Republic (lichenized Ascomycota). 93: 373–378. 2005.
- Guzmán, Gastón & Vagner Gularte Cortez. A new hallucinogenic species of *Psilocybe* (*Agaricales*, *Strophariaceae*) from southern Brazil. 93: 95–98. 2005.
- Helfer, Stephan, see Afyon & al.
- Hu, Hung-Tao & Yun Wang. *Tuber furfuraceum* sp. nov. from Taiwan. 93: 155–157. 2005.
- Jørgensen, Per Magnus, see Guttová & Jørgensen
- Kabaktepe, Sanli, see Bahçecioglu & al.
- Kakishima, Makoto, see Liang & al.
- Knudsen, Kerry & James C. Lendemer. Changes and additions to the checklist of North American Lichens. - III. 93: 277–281. 2005.
- Knudsen, Kerry & James C. Lendemer. Changes and additions to the North American lichen flora. - IV. 93: 289–295. 2005.
- Konuk, Muhsin, see Afyon & al.
- Korf, Richard P. Reinventing taxonomy: a curmudgeon's view of 250 years of fungal taxonomy, the crisis in biodiversity, and the pitfalls of the phylogenetic age. 93: 407–415. 2005.
- Lendemer, James C., see Knudsen & Lendemer
- Liang, Ying-Mei, Cheng-Ming Tian, Zhi-Min Cao, Jun-Xiu Yang & Makoto Kakishima. *Hypoderma qinlingense* sp. nov. on *Sabina squamata* from China. 93: 309–313. 2005.
- Liberato, J.R., I.G. Pascoe, S.D. Campbell, J.G. Wright & R.G. Shivas. *Oidium stachytarphetae* on *Stachytarpheta*, emended: new from Australia and New Caledonia. 93: 145–147. 2005.
- Liu, Pei-Gui, see Zheng & Liu
- Lizárraga, M., G. Moreno, C. Illana & H. Singer. Myxomycetes from Chihuahua, Mexico III. 93: 75–88. 2005.
- Ljaljević Grbić, Milica, see Vukojević & al.
- Illana, C., see Lizárraga & al.
- Liu, Pei-Gui, see Chen & Liu
- Macía, Manuel J., Mary E. Palm & María P. Martín. A new species of *Leptosphaeria* (Ascomycotina, *Pleosporales*) on *Rosaceae* from Bolivia. 93: 401–406. 2005.
- Makhija, Urmila, Archana Dube, Bharati Adawadkar & Gayatri Chitale. Five trans-septate species of *Hemithecium* from India. 93: 365–372. 2005.
- Martín, María P., see Macía & al.
- Moreno, G., see Camino & al.

- Moreno, G., see Lizárraga & al.
- Nevo, Eviatar, see Stajić & al.
- Oran, R. Batur, see Ergül & al.
- Øvstedal, Dag Olav, see Elix & al.
- Palm, Mary E., see Macía & al.
- Pascoe, I.G., see Liberato & al.
- Piątek, Marcin. The species of *Entyloma* (Ustilaginomycetes) on *Convolvulaceae*. 2005. Mycotaxon 93: 323–326. 2005.
- Ramaley, Annette W. *Sulcatistroma nolinae* (Calosphaeriales), and its *Phialophora*-like anamorph. 93: 139–144. 2005.
- Rizzo, David M., see Smith & al.
- Shearer, Carol A., see Ferrer & Shearer
- Shivas, R.G., see Liberato & al.
- Sikorski, Johannes, see Stajić & al.
- Silveira, Rosa Mara Borges da & Jorge Eduardo Wright. The taxonomy of *Echinochaete* and *Polyporus* s. str. in southern South America. 93: 1–59. 2005.
- Singer, H., see Lizárraga & al.
- Singh, Shruti, see Torres & al.
- Smith, Matthew E., James M. Trappe & David M. Rizzo. NATS truffle and truffle-like fungi 11. *Hymenogaster raphanodorus* sp. nov. (Cortinariaceae). 93: 241–246. 2005.
- Stajić, Mirjana, Johannes Sikorski, Solomon P. Wasser & Eviatar Nevo. Genetic similarity and taxonomic relationships within the genus *Pleurotus* (higher Basidiomycetes) determined by RAPD analysis. 93: 247–255. 2005.
- Stevanović, Branka, see Vukojević & al.
- Stevanović, Vladimir, see Vukojević & al.
- Suková, Markéta, see Chlebicki & Suková
- Sullivan, Raymond F., see Torres & al.
- Sun, Xia, Meng Zhang & Tian-Yu Zhang. Taxonomic studies of *Alternaria* 9: two new species and two new records from China. Mycotaxon 93: 283–287. 2005.
- Tian, Cheng-Ming, see Liang & al.
- Torres, Monica S., Marshall Bergen, Shruti Singh, Joseph Bischoff, Raymond F. Sullivan & James F. White, Jr. *Plenodomus morganjonesii* sp. nov. and a discussion of the genus *Plenodomus*. 93: 333–343. 2005.
- Torres, Monica S., James F. White, Jr., Guadalupe Cazares, Marshall Bergen, Joseph F. Bischoff & Raymond F. Sullivan. A new species and its phylogenetic placement in the *Didymella/Phoma* complex (Phaeosphaeriaceae, Pleosporales). 93: 297–308. 2005.
- Trappe, James M., see Grubisha & al.
- Trappe, James M., see Smith & al.
- Trappe, James M., see Wang & al.
- Tulloss, Rodham E. *Amanita*—distribution in the Americas, with comparison to eastern and southern Asia and notes on spore character variation with latitude and ecology. 93: 189–231. 2005.
- Vukojević, Jelena, Milica Ljaljević Grbić, Branka Stevanović & Vladimir Stevanović. *Leptosphaeria raphani* – a new species on *Draba aspera* in Serbia. 93: 265–268. 2005.
- Wang, D.-M., X.-Q. Zhang & Y.-J. Yao. Type studies of some *Ganoderma* species from China. Mycotaxon 93: 61–70. 2005.

- Wang, Long & Wen-Ying Zhuang. *Penicillium brevistipitatum*, a new species isolated from Jilin Province, China. 93: 233–240. 2005.
- Wang, Shengrong, see Guo & Wang
- Wang, Yun, Michael A. Castellano & James M. Trappe. *Melanogaster utriculatus* sp. nov. from Japan. 93: 315–317. 2005.
- Wang, Yun, see Hu & Wang
- Wasser, Solomon P., see Stajić & al.
- Wheeler, Dan, see Grubisha & al.
- White, Jr., James F., see Torres & al.
- Wright†, Jorge Eduardo, see Silveira & Wright
- Wright, J.G., see Liberato & al.
- Yağiz, Dursun, see Afyon & al.
- Yañez-Morales, María de Jesús, see Ayala-Escobar & al.
- Yang, Jun-Xiu, see Liang & al.
- Yao, Y.-J., see Wang & al.
- Yazıcı, Kenan & Ali Aslan. 2005. Six new lichen records from Turkey. 93: 359–363.
- Yıldız, Bayram, see Bahçecioglu & al.
- Yuan, Hai-Sheng & Yu-Cheng Dai. Two new species of *Steccherinum* (Basidiomycota) from China. 93: 173–178, 2005.
- Yuan, Hai-Sheng, see Dai & Yuan
- Zhang, Meng, see Sun & al.
- Zhang, Tian-Yu, see Sun & al.
- Zhang, X.-Q., see Wang & al.
- Zheng, Huan-Di, & Pei-Gui Liu. Type studies on *Albatrellus henanensis* and *A. jianfenglingensis*. 93: 257–263. 2005.
- Zhuang, Wen-Ying. Some new species and new records of discomycetes in China. XII. 93: 99–104. 2005.
- Zhuang, Wen-Ying, see Wang & Zhuang

Reviewers, Volume Ninety-three

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

James B. Anderson	Stephan Helfer	David N. Pegler
André Aptroot	Terry Henkel	Shaun R. Pennycook
Alan W. Archer	Jason Hoeksema	Stephen W. Peterson
Hans Otto Baral	Tsuyoshi Hosoya	Meike Piepenbring
Margaret Barr Bigelow	Kevin D. Hyde	Christian Printzen
Roberto Barreto	Mustafa Isiloglu	Mahendra Rai
Vyrna Beilharz	Teresa Iturriaga	Mario Rajchenberg
Ann Bell	Ken Katumoto	Jack Rogers
Reinhard Berndt	Bryce Kendrick	Amy Y. Rossman
Manfred Binder	Henning Knudson	Gary Samuels
Zoltan Bratek	Linda M. Kohn	Martin Schnittler
Uwe Braun	Richard P. Korf	Roger Shivas
Irwin Brodo	John Krug†	Harrie Sipman
Marcos P.S. Camara	Theresa Lebel	Somsak Sivichai
Lori M. Carris	Adrian Leuchtmann	Stephen L. Stevenson
Michael Castellano	D. Jean Lodge	Göran Thor
Efrén Cazáres	Robert Lücking	James M. Trappe
Dennis E. Desjardin	Patrick M. McCarthy	Kálmán Vánky
Robert S. Egan	Bruce McCune	Giuseppe Venturella
Robert Fogel	David W. Mitchell	Vladimir Vuljanović
James H. Ginns	Gregory M. Mueller	C.J.K. Wang
Halvor B. Gjærum	Holger Müller	Roy Watling
Isabella Grishkan	Tuomo Niemelä	Clifford Wetmore
Gastón Guzmán	Lorelei L. Norvell	Sheng-Hua Wu
Roy Halling	Kerry O'Donnell	Zhu L. Yang
Richard C. Harris	Clark L. Ovrebo	Georgios I. Zervakis
	Mary E. Palm	Wen-Ying Zhuang

MYCOTAXON ONLINE RESOURCES: WWW.MYCOTAXON.COM

Index to fungous and lichen taxa—*Mycotaxon* proudly provides full indices to all authors and taxa that appear in its pages. We continue to print complete indices to authors in each *Mycotaxon* volume. Until 2004 (*Mycotaxon* 1–88), we also printed complete lists of taxa. Because digital files are far more conveniently searched than separate appendices in each print journal, we now post *Mycotaxon* taxonomic indices only online. To read or print the *Index to fungous and lichen taxa* for **Volume 93**, download our posted PDF file by clicking first on INDICES (in the list at the top of any webpage under the *Mycotaxon* header) and then TAXON INDEX, VOL 93.

Cumulative indices—Readers can now swiftly and easily locate taxonomic and author names in the cumulative indices to authors and taxa from earlier *Mycotaxon* volumes. The **Volume 91** author index is now incorporated into the VOLUMES 61–FF CUMULATIVE INDEX. Volume 91–93 taxonomic entries will eventually be integrated into TAXON INDEX, VOLUMES 91–FF. Earlier cumulative taxonomic indices now available for downloading include TAXON INDEX, VOLUMES 61–70; TAXON INDEX, VOLUMES 71–80; and TAXON INDEX, VOLUMES 81–90.

Distributional checklists—*Mycotaxon* posts downloadable PDF files or URL links first published in *Mycotaxon* by authors who amend or update species identifications, nomenclatural revisions, and range & substrate extensions as new data become available. To find the checklist page, first click ONLINE RESOURCES (under the MYCOTAXON header) and then REGIONAL CHECK LISTS. Users may also find checklist PDFs and URLs by clicking on links in the summary abstracts. (Abstracts are found following the PUBLICATIONS -> VOLUME LISTING -> VOLUME NUMBER -> TITLE pathway.)

Search—The **search!** engine option in the top right corner of every *Mycotaxon* webpage is yet another way to search for authors, taxa, and other online resources. Currently it only indexes taxa cited in titles, abstracts, or keywords of published papers. The search button also finds all nomenclatural novelties.

Errata

Volume 92

- p. ii, lines 18-19 for: 8 Short Street / Cambridge, CB1 1LB, U.K.
 read: 510 Lake Blvd., Apt. 166 / Davis, CA 95616
- p. ii, line 26 for:??? -> (1999-2010)
 read: SHAUN R. PENNYCOOK, Auckland, New Zealand (2005-2010)
- p. v, line 3 for: *Phaeoacremonium* species and *Phaeomoniella chlamydospora*
 read: *Phaeomoniella chlamydospora* and *Phaeoacremonium* species
- p.10, lines 40-41 for: [http://aa ... htm](http://aa...htm) read: <<http://aa.uncw.edu/digilib/biology/fungi/taxonomy%20and%20systematics/padgett%20book/>>
- p.18, line 9 ***Achlya ornata*** is a superfluous name. An earlier epithet that could have been transferred exists in *Newbya pascuicola* M.C. Vick & M.W. Dick (2002). We thank Dr. Dick for noting this error.
- p.31, lines 32-33 for: [http://aa ... htm](http://aa...htm) read: <<http://aa.uncw.edu/digilib/biology/fungi/taxonomy%20and%20systematics/padgett%20book/>>
- p.262, line 41 for: ***Ophiostoma angusticollis*** read: ***Ophiostoma angusticolle***
- p.387, line 7 for: *H. balaghattensis* read: *H. balaghatense*
- p.388, line 15 for: ***H. balaghattensis*** read: ***H. balaghatense***
- p.388, line 36 for: ***Hemisthecium balaghattensis*** read: ***Hemisthecium balaghatense***
- p.417, line7 for: *C. saccharume* read: *C. sacchari*
- p.418, line 31 for: ***Corynespora saccharume*** read: ***Corynespora sacchari***
- p.420, line 1 for: *C. saccharume* read: ***C. sacchari***
- p.425, line 8 for: *Corynespora rhaps-humulisi* read: *Corynespora rhapsidis-humulis*
- p.425, line 18 for: ***Corynespora rhaps-humulisi*** read: ***Corynespora rhapsidis-humulis***
- p.426, line 1 for: *C. rhaps-humulisi* read: *C. rhapsidis-humulis*
- p.426, line 5 for: *C. flagellatum* read: *C. flagellata*
- p.427, line 6 for: ***Corynespora flagellatum*** read: ***Corynespora flagellata***
- p.431, lines 9-10 for: *C. ficus-altissimae* read: *C. fici-altissima*
- p.431, line 21 for: ***Corynespora ficus-altissimae*** read: ***Corynespora fici-altissimae***
- p.433, line 6 for: *Corynespora ficus-altissimae* read: *Corynespora fici-altissimae*
- p.497, line 21 for: *Corynespora ficus-altissimae* read: *Corynespora fici-altissimae*
- p.497, line 22 for: *Corynespora flagellatum* read: *Corynespora flagellata*
- p.497, line 24 for: *Corynespora rhaps-humulisi* read: *Corynespora rhapsidis-humulis*
- p.498, line 10 for: *Ophiostoma angusticollis* read: *Ophiostoma angusticolle*
- p.500, line 7 for: ***Villareal*** read: ***Villarreal***
- p.500, line 33 for: ***Crous***, see read: ***Crous***, Pedro W., see
- p.501, lines 26-37 **Delete** (entire entry: ***Dai*** through 2005.)
- p.501, line 25 for: *Acrogenospora* read: *Acrogenospora*
- p.501, lines 25 -26 for: ***Hong Zhu***, read: ***Zhu, Hong***, [on p.504]
- p.502, line 37 for: ***Villareal*** read: ***Villarreal***
- p.503, line 23 for: ***Villareal*** read: ***Villarreal***
- p.503, line 36 **Delete** (entire entry: ***Wang*** through ***Wang***)
- p.503, lines 38-39 for: *Phaeoacremonium* species and *Phaeomoniella chlamydospora*
 read: *Phaeomoniella chlamydospora* and *Phaeoacremonium* species
- cov.3, line 2 for: *Phaeoacremonium* species and *Phaeomoniella chlamydospora*
 read: *Phaeomoniella chlamydospora* and *Phaeoacremonium* species

New!

MYCOTAXON Nomenclature Editor

In early September, MYCOTAXON appointed an assistant to the Editor-in-Chief, whose workload is now too heavy for one individual. MYCOTAXON Editorial Board member, Dr. Shaun Ross Pennycook, volunteered to screen manuscripts for nomenclatural errors before final editorial review. Our new Nomenclature Editor comes to us from Manaaki Whenua Landcare Research in Auckland, New Zealand, and is a fellow member of the IAPT's permanent Nomenclature Committee for Fungi. The MYCOTAXON Editor-in-Chief heartily welcomes Shaun, who will be the first editor to receive new submissions.

New MYCOTAXON submission procedure (effective immediately)

Authors are asked to download our *new* MYCOTAXON submission form and *revised* MYCOTAXON MSWord shell (with explanation of journal styles, requirements, 'clones' & graphics formats) from our *Instructions to Authors* webpage on <www.mycotaxon.com> before preparing a paper for submission to our journal. [These files are also available as Email attachments from the Editor-in-Chief <editor@mycotaxon.com> on request. New *Instructions to Authors* will be available online by December and in MYCOTAXON 94, scheduled for the usual January delivery.]

After peer review by two experts (one of whom has checked English grammar, nomenclature, and taxonomic authorities), manuscript text should be presubmitted directly to <PennycookS@LandcareResearch.co.nz> for nomenclatural review. Authors should include the (i) completed submission form, (ii) peer reviewer Email addresses, and (iii) formatted text, legends, and tables (but *no* graphics or illustrations). The Nomenclature Editor will return annotated files with a list of needed corrections to the authors, reviewers, and Editor-in-Chief. As final submission text *must* be correct, authors may again wish to consult their peer experts during revision for final submission.

Step 1 — Peer Review

__Authors send formatted manuscript text + MYCOTAXON peer review forms to **two** experts for presubmission review. At least one reviewer must agree to check English, nomenclature, & author citations prior to MYCOTAXON presubmission.

__Peer reviewers (i) return edited manuscripts & detailed comments to authors and (ii) Email forms & *brief* review summaries to authors & MYCOTAXON Editor-in-Chief.

Step 2 — Nomenclature Review

__After revising their manuscript, **authors** send the MYCOTAXON submission form, peer reviewer Email addresses, and formatted text clones (*no* graphics, and with manuscript text, legends, and tables in 3 separate files) to our Nomenclature Editor <PennycookS@LandcareResearch.co.nz>.

__The **Nomenclature Editor** returns the annotated clones with his list of needed corrections to the authors, peer-reviewers, and Editor-in-Chief.

__The **authors** correct text clones (and consult peer reviewers, if necessary).

Step 3 — Final submission*

Authors Email/post the following to the Editor-in-Chief <editor@mycotaxon.com>:

- __ One completed MYCOTAXON submission form,
- __ One manuscript PDF/MSWord file **or** printed copy showing all text, legends, tables, footnotes & graphics in place,
- __ One text clone plus table/legend clones as appropriate (text only, **no** graphics, and with all tables in 1 **table clone**, and all footnotes/legends in 1 **legend clone**), *and*
- __ Artwork and graphics (TIF, EPS) files. Set halftone TIFs to 300 dpi and line/phytotree TIFs to 900-1200 dpi per 4.33"width (4.33" = 11 cm). Film-based photographic halftones and original line drawings are still accepted and may be sent by post.

NOTE: remove color from all digital graphics files by converting **all** halftones to **grayscale**, as color modes (e.g., RGB, CMYK) are *three times* the grayscale digital file size. Send digital phylotree & line drawing TIF files in **grayscale** or **bitmap** mode.

*Authors wishing to submit author-prepared PDFs must first **pre-flight** their files through Sheridan Press before sending to the Nomenclature Editor or Editor-in-Chief.

Step 4 — Final editorial review and press-preparation

- __ The Editor-in-Chief acknowledges submission, usually within two weeks.
- __ After editorial review, the Editor-in-Chief *either* Emails approval of files and requests author assurance that all text is now correct **or** returns marked clones to the author for correction.
- __ Authors return (with revisions when needed) a paragraph stating that there are no text errors and granting the Editor-in-Chief permission to adjust graphics, legends, and tables as needed during press preparation.
- __ The Editor-in-Chief processes all files through InDesign to prepare a press-quality PDF file to be sent to the authors for final inspection before publication.

Questions? — Write the Editor-in-Chief!

The Editor-in-Chief <editor@mycotaxon.com> is always available to answer questions regarding suitability of manuscripts for MYCOTAXON and to help guide prospective authors through the submission process.

Lorelei Norvell
MYCOTAXON Editor-in-Chief
October 10, 2005

MYCOTAXON is published quarterly during the periods of January–March, April–June, July–September, and October–December by MYCOTAXON, LTD., 316 Richard Pl., Ithaca, NY 14850-0264. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2005: In U.S. and possessions, one year, \$330; reduced rate for personal subscribers, one year, \$150. Foreign subscriptions, add \$40 for IMEX air mail.

POSTMASTER!
Send address changes to MYCOTAXON, LTD.
P.O. Box 264, Ithaca, NY 14851-0264 USA

NATS truffle and truffle-like fungi 12: <i>Rhizopogon ater</i> sp. nov. and <i>R. brunsi</i> sp. nov. (<i>Rhizopogonaceae</i> , Basidiomycota)	Lisa C. Grubisha, James M. Trappe, Adrian R. Beyerle & Dan Wheeler	345
Coprophilous mycobiota of Oman	Abdulkadir E. Elshafie	355
Six new lichen records from Turkey	Kenan Yazıcı & Ali Aslan	359
Five trans-septate species of <i>Hemithecium</i> from India	Urmila Makhija, Archana Dube, Bharati Adawadkar & Gayatri Chitale	365
<i>Leptogium diffractum</i> in Slovakia and Czech Republic (lichenized Ascomycota)	Anna Guttová & Per Magnus Jørgensen	373
Taxonomic revision of the myxomycetes from Cuba deposited in the Farlow Herbarium (USA)	M. Camino, G. Moreno & A. Castillo	379
A new species of <i>Leptosphaeria</i> (Ascomycotina, <i>Pleosporales</i>) on <i>Rosaceae</i> from Bolivia	Manuel J. Macía, Mary E. Palm & María P. Martín	401
Reinventing taxonomy: a curmudgeon's view of 250 years of fungal taxonomy, the crisis in biodiversity, and the pitfalls of the phylogenetic age	Richard P. Korf	407
Indices & Information		
<i>Nomenclatural novelties proposed in volume 93</i>		417
<i>Author index</i>		418
<i>MYCOTAXON online resources—Index to Fungous and Lichen Taxa, cumulative indices, distributional checklists & search features</i>		422
<i>Reviewers</i>		423
<i>Errata</i>		424
<i>NEW! MYCOTAXON Submission procedures</i>		425

